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ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

Edited by
LEWIS STEPHEN PILCHER, M.D., LL.D.
of New York

With the Association of
JAMES TAFT PILCHER, B.A., M.D.

and the Collaboration of
W. SAMPSON HANDLEY, M.S., M.D., F.R.C.S.
of London

COMMEMORATIVE NUMBER

IN HONOR

of the Completion of Forty Consecutive Years of Editorial Labor in the Development and Conduct of a Monthly Review of Surgical Science and Practice

by

LEWIS STEPHEN PILCHER

the papers in this issue of the

ANNALS OF SURGERY

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FOREWORD

THE COMMEMORATIVE NUMBER OF THE ANNALS OF SURGERY

With this issue of the Annals of Surgery for January, 1925, the journal enters upon the forty-first year of its publication. During this entire period the editing of the journal has remained under the direction of one man, the one under whose direction the first number was issued, Lewis Stephen Pilcher. As to the character of that direction the steady growth of the Annals of Surgery in the approval and support of the surgeons of the world is sufficient evidence. At the end of so long a period of such activity, to be still vigorous and capable in the prosecution of editorial work, is a record which has been rarely equalled.

The publishers of the Annals have thought it sufficiently important to be marked by making this issue of January, 1925, a special number, which by its size, the character and number of its contributors, and the quality of its contents should in some measure indicate their appreciation of the eminent service rendered by its editor during so many years. They take pleasure therefore in now presenting the January, 1925, issue of the Annals of Surgery as one of special compliment to Dr. Lewis Stephen Pilcher to commemorate the completion by him of forty years of service as its Editor.

J. B. Lippincott Company.

ANNALS *of* SURGERY

VOL. LXXXI JANUARY, 1925 No. 1

THE EARLY DAYS OF THE ANNALS OF SURGERY

BY WILLIAM WILLIAMS KEEN, M.D.

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THE "Early days of the ANNALS OF SURGERY," as "Paddy" would say, were when it was *not* the ANNALS OF SURGERY.

In my library I had a very thin Volume I, dated 1879.* Its name is the ANNALS OF THE ANATOMICAL AND SURGICAL CLUB OF BROOKLYN. It has but 102 pages, and covers the years 1878–1879. It contains the roster of the twenty-five valorous members of the club. Pilcher was the President and Fowler—the other Brooklyn twin—the Secretary. The first meeting had been held on June 17, 1878.

I use the adjective "valorous" advisedly, for the Act of Incorporation therein printed, dated September 25, 1879, contemplates an expansion into a medical school, a museum, a library, a laboratory, lectures, and printed volumes of their ANNALS. The Brooklyn twins were the editors then and thereafter of course.

On November 8, 1879, the name of the Brooklyn Club was changed to Brooklyn Society.

Volume II, 1880, comprised 500 pages. It grew like Jonah's gourd, for 1881 required two stout volumes, III and IV. 1882 and 1883 also required two similar volumes, each year, numbered from V to VIII.

Meantime, the name of the ANNALS had been twice changed on Volumes III and IV to the ANNALS OF ANATOMY AND SURGERY. What a restless lot of progressive mortals they were!

But, alas, Volume IX suddenly shrunk to one thin, slender volume of but 52 pages, so thin that it reminds me of a friend of mine who was so tenuous that when he had a pain in the neighborhood of his diaphragm, he declares that he was unable to decide for a time whether it was "a backache or a bellyache."

The reason for its emaciation is that it covers only the month of January, 1884, but it is Volume IX all the same. But it was a case of "recouler pour mieux sauter." It had decided to develop into a full blown, independent, important, purely surgical "hardy annual." Its name from 1885 on is the one now familiar the world over, THE ANNALS OF SURGERY, for years the only

* This and its eight successors are now in the Library of the College of Physicians, of Philadelphia.

purely surgical journal in the English language in the world. Moreover, its editors now were international—Pilcher for America, and Charles B. Keetley, F.R.C.S., for Great Britain. Very properly it begins with Volume I, but none the less am I rather sorry to confess, their disowning the nine authors of its being.

To-day, we welcome Volume LXXXI with Pilcher still at the helm. But during these forty years, this surgical Moses has had his arms constantly upheld by various distinguished American and English collaborators.

I feel a sense of pride as I look over these early nine volumes, for I find, on May 10, 1881—over forty-three years ago—I made an address before this stalwart Brooklyn Society on "The Clinical Anatomy of the Lower Extremity, Especially of the Knee and Ankle-joints," which appears in Volume III for 1881.

In Volume V, for 1882, also, I relate a sad case in which a would-be surgeon, forgetting its anatomy, injected ten drops of undiluted Monsel's solution into an aneurism of the superficial palmar arch. This was followed, of course, by immediate and complete obstruction of the blood-vessels to all the fingers and a swift spreading gangrene, for which I was obliged to amputate the hand of a little girl.

Moreover, I assisted at the "accouchement" of the real ANNALS OF SURGERY by a paper in Volume I on "Combined Tubular and Capillary Drainage of Large Wounds."

Since then, the ANNALS has published not a few papers which I have considered it a privilege to contribute. But I ought not to mention these small personal contributions, for the whole English-speaking surgical world has enriched its pages with a constant stream of papers recording every important surgical advance during the life of its distinguished Editor.

MASTERS OF SURGERY IN THE EARLY YEARS OF THE ANNALS OF SURGERY

By William James Mayo, M.D.
of Rochester, Minn.

For forty-five years the American Surgical Association has represented the best in American surgery, and the greater number of the papers read before its annual meetings have been published in the Annals of Surgery. I have before me some of the first volumes of the Annals of Surgery and as I slowly turn the pages, they bring back memories of that far-away day in April, 1885, when, shortly after leaving medical school, I went to Washington to attend, as an interested spectator, a meeting of the American Surgical Association.

The American Surgical Association was founded June 1, 1880, by the most distinguished American surgeon of his time, Dr. Samuel David Gross, Professor of Surgery at Jefferson Medical College, Philadelphia, and author of a text-book on surgery, conceded to be the best among contemporaneous works of its kind. With Gross were a few other choice spirits who were instrumental in organizing this society of limited membership; of these our own beloved William Williams Keen, Dean of American surgeons, alone survives. The association has always been characterized by the high ideals of its founders, whose fine traditions it has ever maintained. Gross continued as president for the first three years, when, owing to failing health, he declined to serve longer, and the eminent surgeon, Edward Mott Moore, of Rochester, New York, was chosen to succeed him. Moore in turn was followed by William Thompson Briggs, of Nashville, Tennessee, Professor of Surgery at the University of Nashville. The fourth president of the association was Moses Gunn, of Chicago, who was elected at the meeting in 1885.

I can picture Gunn as I used to see him in his clinic when I passed through Chicago, back and forth between Ann Arbor and home, with white Dundreary whiskers, not drooping, but waxed to stand out, dressed in outing clothes, riding boots, a crop in his hand, lecturing on surgery to the students of Rush. He was a fine clinical surgeon, an excellent teacher, and the first, or one of the first, to advocate operating for all depressed fractures of the skull, simple or compound, without regard to whether or not they were producing symptoms. The practice at this time was to operate only in cases of simple depressed fractures in which the depression was sufficient to produce symptoms. Gunn was convincing in pointing out the danger that even the milder type of depressed fractures might cause epilepsy later in life.

Christian Fenger, born and educated in Denmark, was the beloved father of modern surgery in the West. Modest, quiet, with halting tongue, he was one of the early fellows of the American Surgical Association and took a prominent part in the scientific discussions of its proceedings. He was at that

time Professor of General Anatomy and Pathologic Anatomy in the Chicago Medical College (Medical Department of Northwestern University). I never think of Fenger without emotion. Kindly, tolerant, interested only in the science of surgery, especially in surgical pathology, he devoted himself to helping along the higher education of young men. He appreciated the powerful influence to be exercised in the future by these young trained men, and worked with them, not as a paid teacher, but as a fellow craftsman who loved his art and desired in every way to advance surgical knowledge.

John B. Murphy, Malcolm Harris, Frank Billings, Albert J. Ochsner, and many others formed a group of men who were to look back on Fenger as the Master Surgeon. For many years Fenger's clinics at the Passover Memorial Hospital at Chicago were given on Thursday, and my brother and I used to leave Rochester on alternate Wednesday nights to spend Thursday with Fenger, returning Thursday night with a store of scientific pabulum for the digestion of which the time between trips was not sufficient. Fenger made many great contributions to surgery, of which the most memorable to me, were his demonstrations in surgery of the kidney, especially of hydronephrosis from kinking of the ureter, and ball-valve stone in the common duct.

Fenger's love of truth and disregard of self were illustrated at a certain meeting of a Chicago medical society which I happened to attend. Fenger was talking, with illustrations, about the common duct, and pictured the portal vein as lying anterior to the duct. Arthur Dean Bevan, at that time teaching anatomy at Rush, pointed out that the portal vein had its position behind the duct. So great was the reverence for Fenger that this interruption was regarded by many of the men present as being almost sacrilege. However, at the next meeting of the society, Bevan brought a fresh cadaver and made a dissection to demonstrate the position of the vein in relation to the common duct. Fenger thanked Bevan for calling his attention to the fact and said that Bevan was quite right.

Published serially in the ANNALS OF SURGERY, during the first year of its existence, 1885, was one of the great contributions of Nicholas Senn, "Air Embolism." Senn was born in Switzerland and came with his parents to Wisconsin when a lad. He first practised medicine in a small town and later in Milwaukee, where his extraordinary industry quickly attracted attention, and he became a protégé of Fenger. He was the most prodigious worker I have ever known. His knowledge of German medical literature and his indefatigability were valuable assets. So far as teaching the general profession was concerned, Senn did more good than any surgeon of his time in this country. He had a most retentive memory, and in his harsh, strident voice, he delivered clinical lectures based on modern surgical pathology brought out by the work of Pasteur and Lister, which attracted general attention. Whenever it was possible, I attended Senn's lectures, and always with great profit. His was a voice in the wilderness, raised to the medical profession as a whole, and teaching the fundamentals which at that time were little understood by more than a few men in this country. He was one of the first to do

experimental work in surgery, and to popularize scientific methods of experimentation. While no one of his experimental procedures has survived, a tremendous stimulation resulted from his undertakings. I scarcely need mention the bone plates for intestinal anastomosis which inspired Murphy to produce the Murphy button, the most brilliant surgical device of all times. Senn had the general prejudice of his time against training a competitor, and he did not leave a surgeon of the first rank who could call him Master.

When Charles T. Parkes, Professor of Surgery at Rush Medical College, died, Albert J. Ochsner was his chief of staff. Senn came to Chicago to take Parkes' place, and inherited Ochsner, an arrangement which lasted several years. It was quite noticeable that Senn was worried by Ochsner's ability as a surgeon. Like others of his time, Senn was accustomed to being the only figure in the spotlight. He was one day delivering a clinical lecture, the case in point being that of a woman with a very queer abdominal tumor. After talking at considerable length on the points of interest, quoting extensively, and always from foreign writers, he turned to Ochsner, standing interestedly by the side of the patient, and said, with something approaching contempt in his voice, "Perhaps our chief of staff can tell us what is the matter with this patient." Ochsner promptly replied, "I think the tumor is a lithopedion." This was received with derision by Senn, who went into detail to explain that the tumor could not be a lithopedion, but when he opened the abdomen of the patient, he saw that Ochsner's diagnosis was correct. The large audience cheered Ochsner to the echo. Through my desire to learn what I could of surgery, I had sought the acquaintance of Ochsner. On this occasion I followed him into the anteroom after the lecture, and said, "This will end you in this clinic." He asked, "What do you mean?" To which I replied, "You will find out." And he did.

Brilliant Roswell Park, of Chicago, and later of Buffalo, always reminded me of Billroth, the Viennese surgeon, Father of Gastric Surgery. Roswell Park was a cultured gentleman. Artistic to his finger tips, he was a musician of great skill, and an improvisor of musical themes. I remember him best for the mental characteristics of the true artist. The Mütter Lectures on surgical pathology which he delivered read like a novel and were inspiring to the last degree. They were afterward published in book form, comprising only one of his many notable contributions to surgical literature.

Arpad Geyza Gerster came to New York from Hungary in 1873. He was first with the German Hospital in New York City as attending surgeon, and later served in the same capacity at the Mt. Sinai Hospital. From 1884 to 1895, he held one of the two chairs of surgery at the New York Polyclinic Medical School. Gerster had many of the characteristics of Fenger. His book, "The rules of aseptic and antiseptic surgery," published in 1888, was the most useful and the most talked-of book of its time, for it presented modern surgery in a form easily understood. Gerster was a great teacher, and preëminently a diagnostician. His love of truth and hatred of sham were

his outstanding characteristics. It was a happy day for me when I came under his influence, and I shall always have for him reverence and respect.

William T. Bull, Professor of Surgery of the College of Physicians and Surgeons of New York (Columbia University) and Maurice H. Richardson, of Boston, Professor of Surgery at Harvard University, in my opinion had the best surgical judgment of any surgeons with whom I was personally acquainted. When I first knew Bull, he had a hospital emergency service in the crowded Five Points neighborhood in lower New York, a rendezvous of criminals. It was here that he successfully sutured a gunshot wound of the intestine, the first reported recovery from such an injury. This success at once gave him an international reputation which his fine surgical career fully justified.

The solid reputation of Maurice H. Richardson is too well known to require comment. Richardson had been much impressed by French surgery, through which he became a master of technic and acquired that intuitive diagnostic ability which has always characterized the French. Richardson was a great teacher, with dramatic instinct in presentation. A master draftsman, with pencils of colored chalk in each hand, he drew swiftly, using both hands, picturing the subjects of his discourse. On one occasion I remember that he had removed a greatly enlarged spleen, in an emergency case. The history of the case led him to believe that the spleen was leukæmic in type, but with characteristic modesty he said that, inasmuch as the patient had recovered, the recovery in itself would seem to disprove his diagnosis. Loyal, kindly, generous, his name will live not only in surgical literature, but also in the hearts of all who were privileged to know and love him.

More than twenty-five years ago Albert J. Ochsner and I visited Canada together. Among those of striking personality whom we met was James Bell, of Montreal, Professor of Surgery in McGill University Medical School, and Chief Surgeon, to the Royal Victoria Hospital. He was a splendid teacher, and a sound clinical surgeon of the British type. He made many valuable contributions to surgery, among his best, that on operations for carcinoma of the larynx. His rounds of hospital wards were memorable; he exhibited a broad knowledge of surgery and fine judgment in advising surgical treatment.

As one passes to the South, the noble figure and fine face of Hunter McGuire, of Richmond, Virginia, come to mind. McGuire was one of the founders of the American Surgical Association, and one of its most distinguished fellows. During the Civil War he was the surgeon-in-chief of Stonewall Jackson's army. I remember well his address as President of the American Medical Association at the Milwaukee meeting in 1893, in which he brought out ingenious methods for giving relief to patients suffering from prostatic hypertrophy, which at that time had not come into surgical view.

I have mentioned only a few, and those deceased, of the Americans by birth or adoption, early fellows of the American Surgical Association, whose love of surgery led them to great achievements. Their spirit resides with us, and

their memories are part of the heritage of our country. I should like to speak of many of the surgeons of an older generation who are still living, but their number forbids. As I look back on these men who influenced me so greatly, I realize that their influence lay not in their craftsmanship, but in their high qualities of mind. Many of the best surgeons have been poor technicians, but their results have been splendid. It is the mind of the surgeon, and not his hands, that merits chief consideration. Is it any wonder that attending a meeting of surgeons of such calibre should have inspired me, and that from a rear seat listening to the papers and discussions, I should have felt like a hungry, penniless boy in front of a bake-shop window, that as I looked at Dr. Jacob Rowland Weist, on the platform, who was not only a Fellow of the American Surgical Association, but also its Secretary, I should have thought, "Is it possible for a small-town man to get into the company of these giants, and sit with the mighty?" Weist lived in Richmond, Indiana, a fine but small city.

Knowing that the transactions of the American Surgical Association were to be published in a new surgical journal, the ANNALS OF SURGERY, I at once subscribed. I read every number; I still have every copy. For forty years, the ANNALS has been one of the chief sources of my surgical information. It has been my practice throughout my entire professional life, to spend at least one hour a day reading medicine. My medical journals are always saved for me when I am away, and I go over them carefully on my return. If on any one day I read several hours, I give myself credit for only the one hour. If I fail to read the hour, I charge myself with the omission, and scrupulously pay the debt.

With few exceptions, the progress of the surgeon lies in the medical journal. Medical journals are not only a source of information, but also a source of news, and surgical news, like other news, is open to correction day by day. Many books on surgery are of the greatest value, but there are also others of less value. Sometimes one is unduly influenced by a book because it seems so real, with its fine binding and heavy paper, that one sees, not the meager merit of the man who wrote it, but rather the building with the brown stone front and plate-glass windows where it was published.

Of the distinguished editor of the ANNALS OF SURGERY, a Fellow of the American Surgical Association, and later, its President, what shall I say? In 1893, my name appeared in the ANNALS for the first time, over a little paper on volvulus of the sigmoid flexure successfully reduced after abdominal section. In 1895, my brother and I sent to the ANNALS our earliest joint contribution. For the first time we believed we had something sufficiently valuable not to seem a profanation of its pages. My brother's contribution was the report of a case in which an open injury of the knee-joint in a young man was accompanied by extreme sepsis, and apparently amputation alone would save life. He split the knee-joint wide open from side to side across the front, bent the leg back and packed the space with iodoform gauze, and the patient eventually recovered. My contribution was the report of a case

of accidental traumatic division of the vas deferens, in which I made an end-to-end union. Using a strand of catgut (the catgut at that time was boiled in alcohol which rendered it stiff), with a fine needle on each end, I passed a threaded needle up the lumen of each end of the cut vas deferens for three-fourths of an inch, bringing it out through the side wall. The two ends of the vas deferens were slipped together over the catgut strand, which served as an internal splint, and a knot tied on each side to hold the two portions in position. Recovery followed. I must confess that afterwards the method was used as a basis for a lot of silly work on the vas deferens, but not by me.

This was our unimpressive advent into the surgical high light. Previously, we had each written four or five papers a year, but had confined our contributions or perhaps, more accurately, they had been confined to where they belonged, county, district, and state societies. Occasionally we sent our little papers to some good eastern medical journal, hoping that they would enter the current of the stream, only to have them rejected, and restored to us in the eddy. This was the beginning of almost yearly contributions to the ANNALS. During the forty years of the ANNALS' existence, I have published through its pages forty-two papers. Many of these papers, as they appeared in the ANNALS, were wonderfully improved in English and sometimes in fact, by the kindly, friendly, helpful corrections of the editor. These I noted with care and profit, and to few men do I owe so much as I do to Lewis Stephen Pilcher, Master Surgeon, Editor of the ANNALS OF SURGERY, who for forty years has aided so greatly in shaping the surgical opinion of the English-speaking world.

LUPUS IN ITS SURGICAL ASPECTS

By W. Sampson Handley, M.S., F.R.C.S.
of London, England
surgeon to the middlesex hospital

Tuberculous lupus is a disease which during recent years has largely passed out of the hands of the surgeon into those of the dermatologist. In the near future, it seems likely to be transferred to the radiologist, or to the surgeon-radiologist. Nevertheless, the surgeon cannot wash his hands of the subject, his help may still be called for by his colleagues, and he may be asked for advice about competing non-surgical methods of treatment.

It is especially in cases where a patch of lupus has infected the trunk lymphatics of a limb, and has led to enlargement of the axillary or the inguinal glands, that the dermatologist may call in the surgeon. These cases are well recognized under the name of "tuberculous lymphangitis," and it was a case of this sort referred to me by my colleague, the late Dr. J. J. Pringle, which first aroused my interest in the subject. The surgeon may also be asked to help in cases of lupus epithelioma. He may be called in to excise a small patch of lupus in its early stage.

In all these cases he will feel that he is but a blind guide unless he has clear notions as to the pathology of the disease. It is not enough to know its bacteriology. Its medical therapeutics, if any, lie in the province of the physician. The particular interest of the surgeon who is called in to excise a focus of lupus lies in the answers to the questions. How does it spread, in what layers, and to what extent? How far does the infection extend into apparently healthy tissue? I have re-investigated the subject from this aspect, and I now propose to place the results before my American colleagues.

It may be objected that I am presenting a pathological rather than a surgical paper. In defence I would reply that in my opinion pathology is the only safe guide in surgery. Competing empirical methods of treatment may be multiplied, each supported by a crop of massive statistics, but the question at issue remains undecided. The right line of advance is to study the pathology of the disease before attempting to devise a method of treatment, just as an engineer surveys the country before he attempts to fix the best route for his railroad.

Before I present the evidence, I propose to state briefly and in dogmatic form the conclusions at which I have arrived, for only thus can I hope to hold the interest of the reader. The first assertion I make is that lupus is not a skin disease. It is a disease of the lymphatic system not restricted to the skin, and governed as to its mode of spread by the facts of lymphatic anatomy.

Lymphatic Anatomy.—Only if the lymphatic anatomy of the parietes of the body is known can lupus be understood. Owing to the invisibility of the lymphatic vessels, both to the naked eye and in microscopic sections except

when special and troublesome methods of injection are adopted, lymphatic anatomy is a neglected subject. No clear account of the small lymphatic vessels of the skin and subjacent tissues can be gathered from the text-books. Sappey's magnificent work on the macroscopic side of lymphatic anatomy fails in dealing with the microscopic side of the subject, for his method of injection by mercury did not permit the making of histological sections of the injected tissues.

Fortunately, pathological processes sometimes produce very perfect injections of the lymphatic system, suitable for histological examination. This is

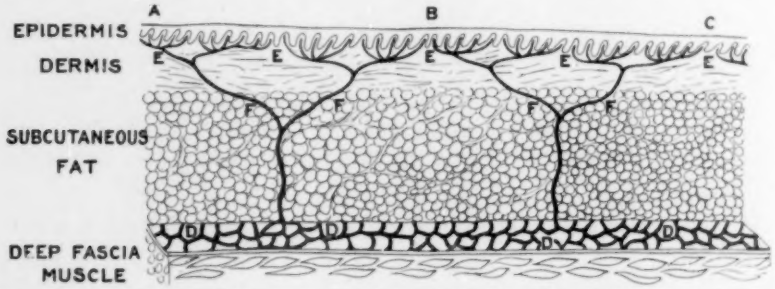

FIG. 1.—To show the lymphatic arrangements of the skin. A schematic vertical section of the skin and subcutaneous fat, with a small horizontal shelf of deep fascia projecting forward from it. Below this is muscle in vertical section. AB and BC are two of the primary lymphatic areas of the skin. These areas measure one-third to half an inch in diameter, and the only lymph-vascular communication between them appears to be by way of the subjacent fascial lymphatic plexus DDDD which is seen on the flat. The lymphatic end-sacs of the skin-papillæ unite by groups of five or six to form small lymphatic vessels, which again unite in the superficial third of the dermis (plane of primary confluence EEE) to form other lymphatic vessels which pierce the dermis vertically and unite just beneath it (plane of secondary confluence FFF) into a smaller number of vessels which run down through the subcutaneous fat to discharge into the fascial lymphatic plexus DDD. Reproduced from the author's paper in "The Lancet," November 26, 1921.

especially the case in melanotic sarcoma, where the lymphatics of the skin, even the very minute ones, may be mapped out by the process of permeation, as black cords full of melanotic cells. The same thing happens in some cases of carcinoma, and particularly in Paget's disease of the nipple. Years of study of these diseases, supplemented by direct injection of the lymphatics of the skin by solution of soluble Prussian blue, have enabled me to form a conception of the arrangement of these vessels which is embodied in the diagram. (Fig. 1.)

The perusal from cover to cover of current text-books, not only on anatomy, but on lymphatic anatomy also, will fail to provide the reader with any coherent idea of the lymphatic arrangements of the skin. He will be told of the existence of two cutaneous lymphatic plexuses, one lying superficially in the dermis, the other, the deep cutaneous plexus of Arnold, lying just deep to the dermis in the subcutaneous fat. The existence of Arnold's plexus was denied by Sappey, and I have sought in vain for any better evidence of the existence of the superficial cutaneous plexus. The authors who described these plexuses did so mainly on macroscopic examination of minute objects requiring the help of the microscope. They were deceived by appearances such as might lead an observer in a wood to think that the entangled branches of adjoining trees were anastomosing together. These so-called plexuses are

merely "planes of confluence" layers in which the union of groups of lymphatics to form a single vessel produces a plexiform appearance.

The first real light on the minute lymphatic arrangements of the skin was supplied by Ranvier from injections of the skin of the auricle in the white rat. He says:

> The lymphatic capillaries form simple or composite culs-de-sac. They do not reach the epidermis, but are separated from it by a distance of .1 mm. Their diameter is relatively considerable, and has an average of .04 mm.; it may attain .05 mm. These are large figures for capillary vessels, and much exceed those of the blood capillaries. No trace could be seen of the supposed plasmatic canals, juice canals, or canaliculi, which, according to certain purely theoretical ideas, form the origin of the lymphatic system.*

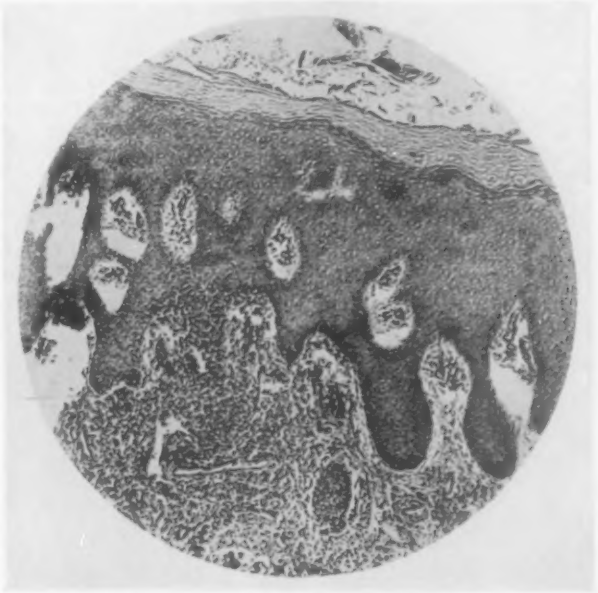

FIG. 2.—From the edge of an area of lupus showing the group of endotheloid cells occupying the centre of each papilla of the corium. Position of these cells shows that they have arisen from the proliferation of the lining epithelium of the lymphatics of origin in this intration, x 95.

This description of Ranvier was confirmed by me for human skin by direct injection, the results of which I described as follows:

> Using soluble Prussian blue as an injection fluid, I have been able to demonstrate that the lymphatics of the skin originate as blind finger-like culs-de-sac in the dermal papillæ. As in the rat, the lymphatics of origin are separated by a thin layer of dermal fibrous tissue from the deep surface of the epidermis. The finger-like processes are continued into narrower vessels, several of which unite together in the deeper layers of the dermis to form a collecting vessel which passes more or less vertically through the subcutaneous fat to join the fascial plexus.†

To this description it must be added that just deep to the dermis, in the place where Arnold saw his imaginary plexus, there is a second plane where numerous tributaries converge to form a small number of single vessels. The fascial lymphatic plexus into which these vessels empty themselves, forms a single network of vessels, co-extensive with the surface of the body, and lying beneath the subcutaneous fat upon the deep fascia. This is the only true parietal lymphatic plexus.

Observations on the mottling of the skin so often seen in healthy infants, and sometimes in adults, and upon the size of wheals, and of the nodular lesions produced when carcinoma invades the skin, have convinced me that

* Ranvier, Comptes rendus de l'Academie des Sciences, 1895, vol. cxxi.

† Cancer of the Breast, page 363.

the skin is divided into small independent lymphatic areas, one-third to one-half inch in diameter, between which little or no lateral lymphatic communication exists.

It is therefore characteristic of pathological processes which spread along the lymphatic vessels that they do not extend in the plane of the skin. To reach areas of the skin adjoining that in which they originate, they must first descend to the deep fascia, reascending to the skin of adjoining areas in a direction opposed to that of the lymph stream. In the same way, though the top-floor rooms of the house in which I am writing adjoin those of the house next door, the only communication between them is down my staircase, along a portion of the street, and up the staircase of the next-door house. Each of the lymphatic areas of the skin is, as it were, divided by complete party-walls from the adjoining lymphatic areas.

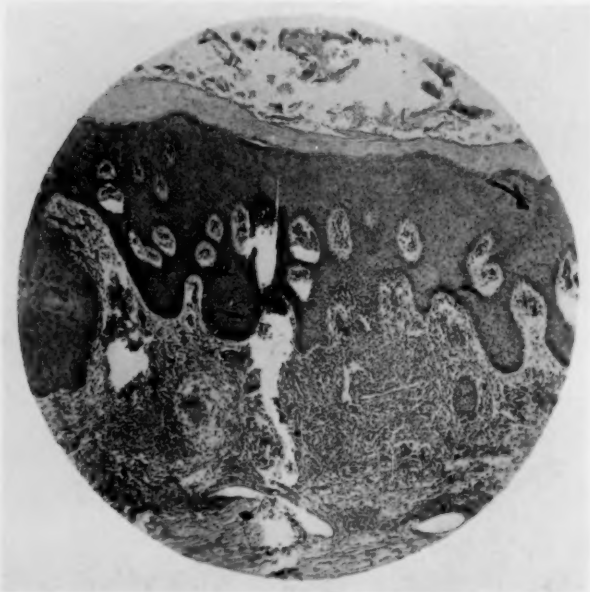

FIG. 3.—Proliferatic lymphangitis of the lymphatics of origin in the skin papillæ. In the centre of each papilla, in the intratia normally occupied by a lymphatic capillary is an irregular group of endothelial cells. In the clervis below is seen typical lupoid granulation tissue x 68.

If we imagine a pathological process originating in a dermal lymphatic, and extending along the lymphatic vessels, we might anticipate that it will rapidly extend to all the lymphatics of the area in which it starts, forming a lesion one-third to half an inch in diameter. Then after an interval, occupied by its descent to the fascial plexus and reascent therefrom, similar lesions will appear in the centre of the adjoining areas, but separated from the original lesion by a small interval. The new lesions extend to the limits of the newly infected lymphatic areas and reaching these limits fuse with the original lesion.

In other words, the peculiar marks of a lymphatic disease as affecting the skin are that:

(a) The lesions are nodular.

(b) They are at first discrete and separate, and only later fuse into one with the original lesion.

(c) The layer primarily affected is the superficial third of the dermis, the layer which is richest in lymphatic vessels.

These peculiarities are well seen in the case of secondary carcinoma

and melanotic sarcoma of the skin. I have proved conclusively that these diseases spread by permeation of the cutaneous and subcutaneous lymphatics. By permeation I mean, of course, the continuous tendril-like growth of cylinders of cancer cells along the lymphatic vessels.

Other peculiarities of these lymphatic diseases are that:

(d) Nodular deposits may appear along the course of the trunk lymphatic vessels.

(e) The glands to which they run become enlarged.

(f) The disease may then further disseminate to the internal organs.

(g) The disease cannot be successfully treated by excision of areas of skin, however large, for it will be reproduced from the infected deep fascia beneath.

FIG. 4.—Section through dermis showing branching network of lines of granulation tissue (lymphangitis). Giant cells darkly stained near centre of field. Lupus of perineum. Slide kindly lent by Dr. Ernest Shaw, Pathologist to the Royal Northern Hospital.

I shall now endeavor to show that tuberculous lupus presents all the marks of a disease spreading by continuity in the lymphatic vessels. It is in fact essentially and primarily a disease of the lymphatics, a destructive lymphangitis of the parietal lymphatic system. If this is the case, it must affect not only the skin, but also the subcutaneous fat and the deep fascia, for these layers also are furnished with lymphatic vessels, though less richly than the skin.

It has of course long been recognized that lupus is in intimate relation with certain affections of the lymphatic system, but these affections have been erroneously regarded as secondary complications of the lupus, and not as a part of the same process. Leloir, in 1888, enumerated these lymphatic "complications" as follows, expressly stating that he regarded them as secondary. He first draws attention to the areas of local lymphatic œdema and pachydermatous skin which may be found near areas of lupus. He next describes, in the skin near lupus patches—especially of the ulcerative variety—acute or subacute attacks of lymphangitis presenting the characters of erysipelas. Sometimes these attacks coincide with necrobiotic softening, or rapid interstitial absorption of lupus nodules. These attacks vary in acuteness and extent, and in the closeness of their resemblance to erysipelas. Most

often on the face they assume the characters of the so-called strumous or white erysipelas. They may be afebrile or accompanied by pyrexia up to 38° to 40° C., with more or less definite febrile symptoms. Leloir distinguishes them from true erysipelas which may also attack the subjects of lupus. The lupoid pseudo-erysipelas is less acute in its course, and does not invade the hairy scalp. Its edge is less defined, and the swelling is, as it were, flattened out. It is often white. In some cases after such attacks crops of fresh tubercles appear in continuity with the original patch or in its neighborhood, or even at a certain distance away from it. These secondary or metastatic eruptions may be either ulcerative or not. In other cases, as may be seen most clearly in the limbs, the tuberculous virus of the lupoid patch in the dermis extends by means of the lymphatic vessels, ascending thus towards the root of the limb. Thus are produced cord-like lymphangitic thickenings along the lymphatics, presenting in their course tuberculous gummata and tuberculous enlargement of the glands. Ultimately the lung on the affected side may become tuberculous, an event signalized by the onset about a week after an erysipelatoid attack of a fresh febrile attack and the appearance of physical signs of apical tubercle. I shall later refer to the treatment of these interesting cases, which appear to have been first described by Leloir. Leloir next deals with enlargement of the lymphatic glands as seen in lupus. These enlargements are, he states, a stage in the centripetal march of the tuberculous virus. He admits that non-tuberculous glandular enlargements may occur in lupus, from local irritation and secondary infections of the lupoid patch, but maintains that many of the enlarged glands bear to the lupus patch the same relation that the glands in secondary syphilis bear to the primary chancre, and that they are due to infection by bacilli from the lupoid patch. Leloir proved his point by experimentally producing tubercle in animals with material taken from enlarged glands in lupus patients. He showed that tuberculous secondary glands may occur both in the ulcerative

FIG. 5.—A group of giant cells lying in the axis of a hypertrophied papilla of the skin in a case of lupus, in the intratia usually occupied by a small lymphatic vessel. Presumably therefore the giant cells are derived from proliferation of the lymphatic endothelium. To the right of the rectia is seen another papilla with its central lymphatic showing proliferative lymphangitis.

and the non-ulcerative forms of lupus. He pointed out that the glands were not necessarily caseous, or much increased in size, that they might present only miliary tubercles, and hence often escape observation. On the contrary, especially in ulcerative lupus, the glands may become very large, may soften, and burst, leaving open sinuses. Secondary glands may disappear by interstitial absorption or by sclerosis. The glands, which remain small, indolent, and elastic (resembling secondary syphilitic glands) are more likely than the large suppurating glands to lead to pulmonary or general tuberculosis. Leloir

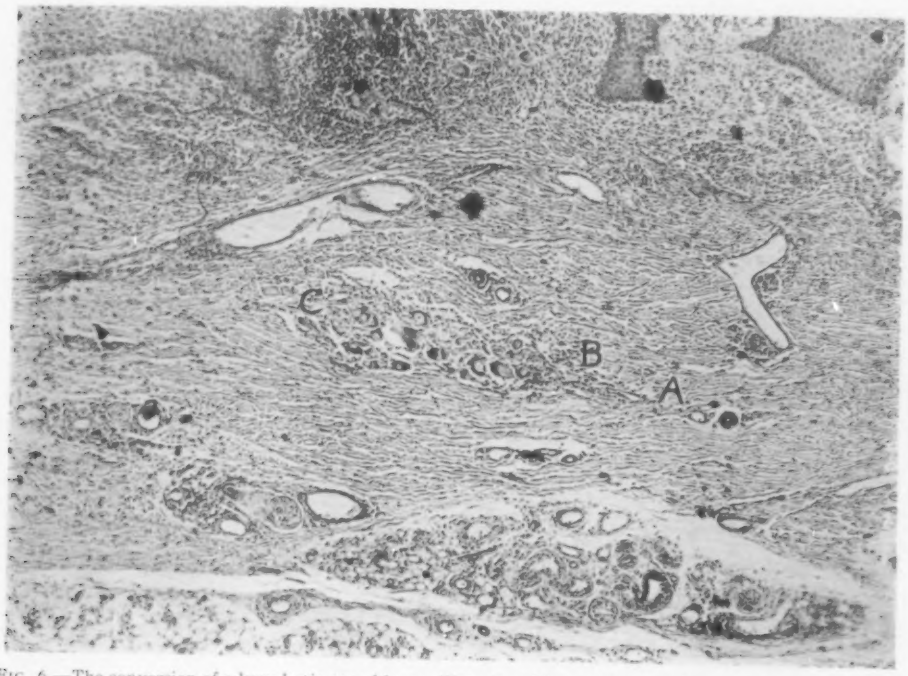

FIG. 6.—The conversion of a lymphatic vessel by proliferation of its endothelium into a solid cord of granulation tissue B C containing giant cells. At A the lumen of the vessel can still be traced.

believes that, to arrest the march of the disease, enlarged tuberculous glands, observed in a lymphatic area where a lupoid patch is situated, should be eradicated. He has several times seen phthisis begin a few days after fugitive enlargements of the lymphatic glands had appeared and subsided. Such is the account given by Leloir of the lymphatic complications of lupus. I ask the reader to note how naturally all the facts detailed by Leloir fall into place, if as I maintain, lupus is from the beginning a tuberculous lymphangitis.

I now propose to consider separately the marks of a lymphatic disease, and to inquire whether or not lupus presents each of them.

(a) *Lupus is a nodular disease*, as every student knows. No explanation has ever been given of this peculiarity. As I have shown, it is determined by the peculiar lymphatic anatomy of the skin. It is a peculiarity of the malignant growths which disseminate by permeation of the lymphatic system that the secondary deposits are nodular. I have shown that in carcinoma

the secondary nodule is often formed by the extension of permeation from a permeated lymphatic into the arborescence of minute lymphatics which unite to form it. I think I shall be able to demonstrate that the nodules of lupus originate in the same way by the extension of a lymphangitis into the initial arborescence of an infected lymphatic vessel. I believe I can thus answer the question, "Why is lupus nodular?"

(b) *The spread of lupus is centrifugal but discontinuous* by the appearance of outlying nodules which subsequently fuse with the main area of disease. The absence of anastomotic communication, except by way of the fascial plexus, between the adjoining primary lymphatic areas of the skin, prevents the direct spread of pathological processes along the skin, by way of the lymphatic vessels. They can only spread by first descending along the lymphatics tributary to the fascial plexus, by then spreading in the plane of the plexus, and by re-ascending to the skin to invade adjoining primary lymphatic areas. It results that though the general trend of such processes is centrifugal, it takes place not by continuity, but by the appearance near the primary lesion of punctate skin nodules which may subsequently merge into it. This is the characteristic spread of carcinoma and melanotic sarcoma. It is highly significant that the same peculiar mode of spread is seen in lupus. Treves (System of Surgery) distinguishes between the spread of the primary focus of lupus at its edge and the formation of fresh spots in the vicinity. Stelwagon also draws attention emphatically to this peculiarity of the disease. It is, I submit, determined in lupus, as in malignant disease, by the anatomical peculiarities of the lymphatic system.

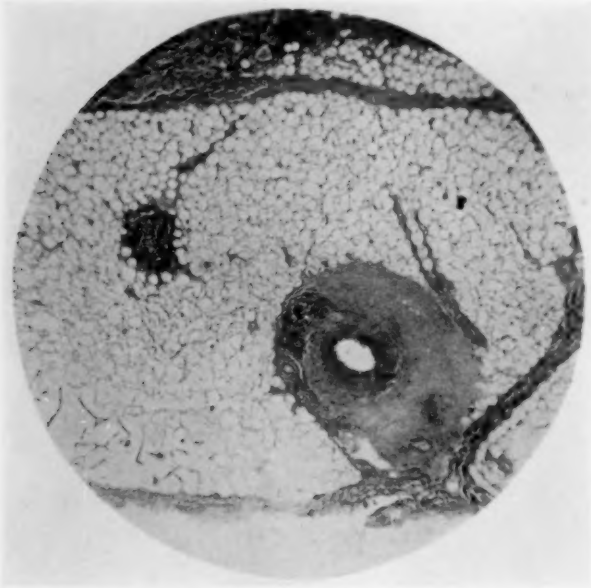

FIG. 7.—Perivascular invasion of the subcutaneous fat along the track of the lymphatic vessels showing the disease is not confined to the skin. From a slide kindly lent by Dr. Ernest Shaw.

(c) *In Lupus, Nodular Deposits May Appear Along the Course of the Trunk Lymphatics.*—The rather rare cases of "tuberculous lymphangitis" will be more conveniently dealt with later in this paper, and from a clinical standpoint. Here I would note that if all lupus is a lymphangitis, these cases have no exclusive right to their designation. It would be better to call them cases of disseminated lupus.

(d) and (e) *Lupus May Affect the Glands and the Internal Organs.*—As Leloir has shown, adenitis and even phthisis may supervene in certain cases of lupus.

(f) *Lupus is Intractable by Skin Excision.*—This point will be more conveniently deferred until treatment is considered. So far I may claim that a prima facie case has been made out for considering lupus a lymphatic disease. Evidently, however, the question can only be finally settled by direct histological examination of the growing edge, including the subcutaneous tissues and the deep fascia of this region.

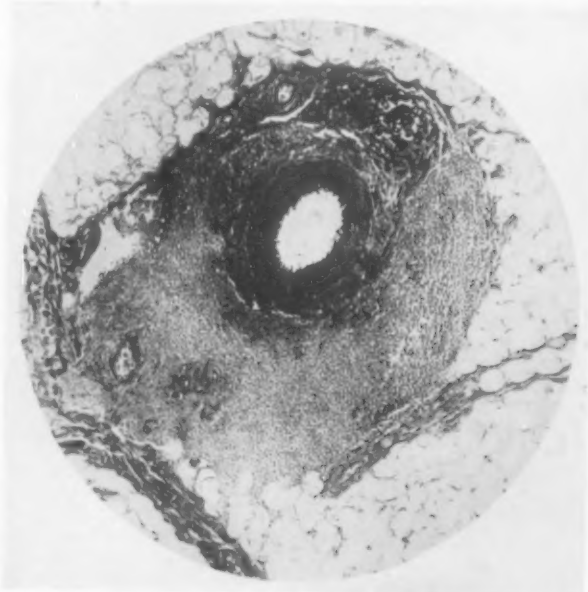

FIG. 8.—A giant cell lying in granulation tissue in the subcutaneous tissue close to an artery, *i.e.*, in the normal intrachia of a constant lymphatic. The section demonstrates the infection of the subcutaneous tissue which appears to be normal in lupus and raises a presumption that the infection is lymphangitic, x 80. Slide kindly lent by Dr. Ernest Shaw.

Microscopic Characters of the Growing Edge.—The great labor which has been devoted to the histology of lupus has hitherto failed to explain why lupus is nodular, why it affects the superficial third of the dermis, why it apparently spreads discontinuously, and why the disease is so obstinately recurrent, although due to an avirulent form of the tubercle bacillus. The fact is that histologists have not based their investigations upon lymphatic anatomy, and have concentrated their attention upon the confused pictures of the later stages of the disease instead of studying the early changes seen at its microscopic growing edge. I must now describe three cases in which I investigated the microscopy of the growing edge of lupus beyond the visible area of disease.

FIG. 8, a.

The difficulty in histology has always been that of tracing the order and succession of the morbid changes in time. In a microscopic section the observer sees an irrevocably fixed moment of the morbid process. What came before

and what will come after is a matter of inference, but in any case as I shall show it is not necessary to guess.

Many morbid processes, starting at one point, spread centrifugally from their focus of origin. I have shown that cancer is such a process, so also are tubercle and leprosy.

The affected area may be considered as a series of circles representing the

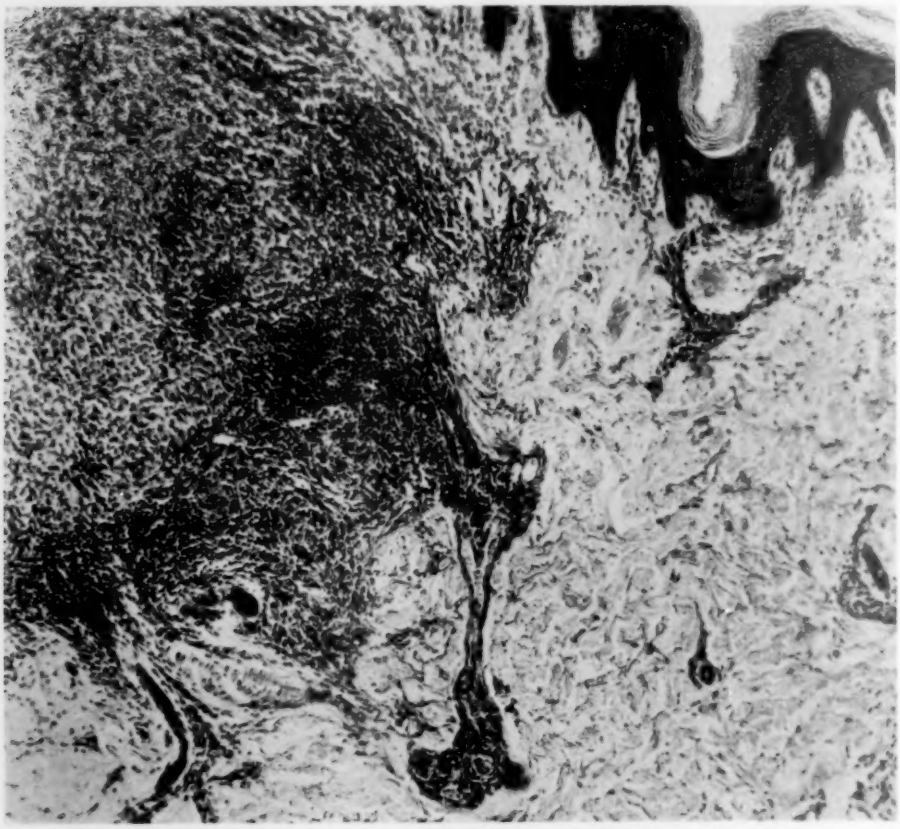

FIG. 9.—X81, taken from the edge of an area of lupus non-exedens, shows on the left a typical lupus nodule, containing giant cells and about $\frac{1}{25}$ inch in diameter. The epithelium over it is thinned. The striated arrangement of the tuberculous granulation tissue and the fan-like expansions which mark the entry of the vessels from below, indicate how it is formed. The nodule originates from the unchecked proliferation of the endothelium of a network of capillary lymphatics in one of the minute lymphatic areas of the dermis. Note the hypertrophy of the papillæ which has resulted from the destruction of the lymphatic system of the skin. In the right half of the figure, which lay beyond the visible edge of the disease, casual observation might detect nothing abnormal, except some papillary hypertrophy. Closer observation shows proliferative lymphangitis, the result of early infection. Note especially a lymphatic junction completely blocked by the proliferative process.

actual size of the lesion at successive periods of time. The innermost circle is the oldest, and here the morbid process will be seen in its late stage. In the zone outside this it is a little less advanced, and increasingly so in the outer zones, until at the outermost zone of the affected area it is seen in its incipient stage.

To know what has happened at E. F. we have only to trace the sequence of changes shown at AB, BC, CD, DE in that order.

Passing in space from A to F, we have unrolled before our eyes a sort of biograph film which shows what has happened or will later happen at each point of the affected area. Expressed in general terms, the assertion I make is as follows: In a morbid process, starting at one point and spreading centrifugally, the sequence in space of the morbid appearances from the circumference of the lesion towards its centre represents their sequence in time

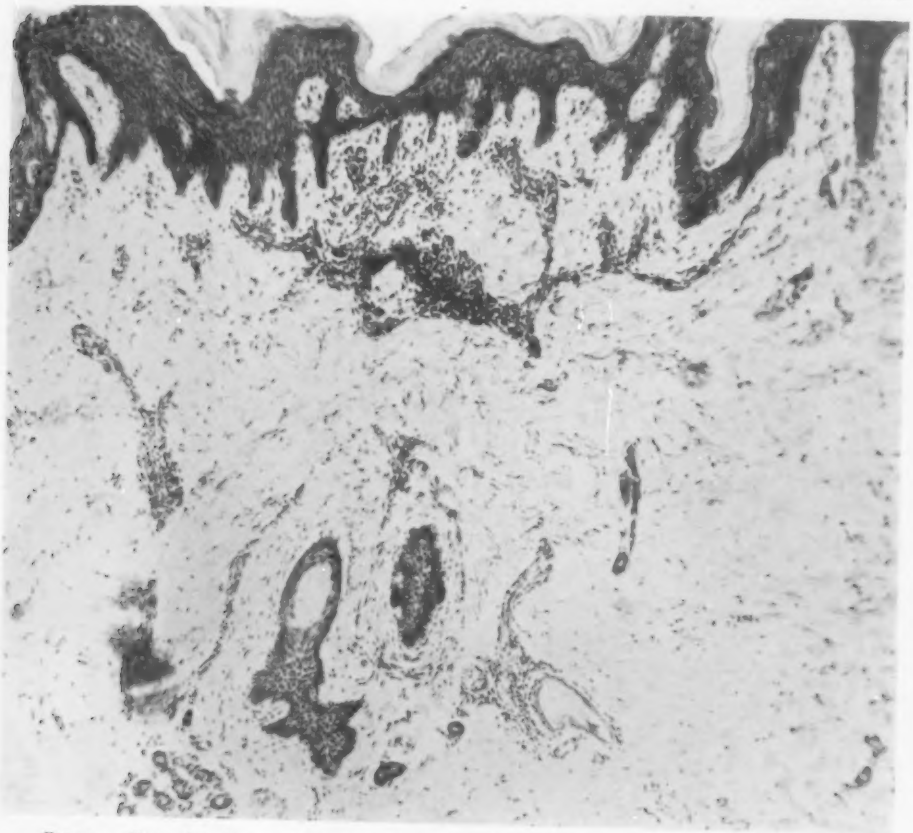

FIG. 19.—X95 taken from near the edge of an area of non-ulcerative lupus, lay beyond the visible edge of the disease in apparently normal skin. The lymphatics of the skin nevertheless show advanced proliferative lymphangitis. A group of the lymphatic end sacs, which lie in the skin papillæ, is seen uniting in the plane of the section to form one of the vertically running lymphatics which pierce the dermis. To the left is seen another Y-shaped lymphatic junction, which also is converted into a solid cord of cells by proliferation of its endothelium.

at each point of the affected area. The method is simple and scientific, it replaces guessing by legitimate inference, but so far as I know, it had never been systematically applied in histology prior to my work on the dissemination of cancer. In the present paper I hope to illustrate its application to the problems of lupus.

In order to appreciate the interpretation of the histological appearances, it is necessary to bear in mind two leading facts of lymphatic anatomy, namely that:

(1) Wherever a small artery and vein (or two veins) are seen in

company there are also small comitant lymphatic vessels, usually two in number, are found.

(2) A lymphatic vessel forms the central core of each cutaneous papilla, just as it does of the intestinal villus.

The first of these facts was brought forcibly home to me while I was studying the dissemination of melanotic sarcoma. Here in the zone of permeation it was the rule to find two small cylinders of black growth, *i.e.*, permeated lymphatics, accompanying each arteriole and its comitant venule.

The second fact I have demonstrated directly by injection of the lym-

FIG. 10a.—An outline key diagram to the preceding figure. The tuberculous lymphatics are marked by heavy shading.

phatic vessels of the skin. These facts provide the means for the recognition of lymphatic vessels in histological sections.

I will now describe my observations on the histology of the growing edge of lupus.

CASE I.—A patch of warty lupus at the base of the index finger. The most striking feature of the section is the great papillary hypertrophy seen in its central diseased portion. Measurement shows that at one end of the section in healthy skin the papillæ measure two units on the micrometer scale. Passing across it they increase in length to 10, 12, and, as a maximum, to 20 units of the scale. Then a decrease begins, and at the other edge of the section the length averages only three units. At the edge of the affected area, where there is no papillary hypertrophy, the first change noted is that the centre of each papilla is occupied by a more or less solid column of endothelial cells irregularly arranged. (Figs. 2 and 3.) There is here no round-celled infiltration. From the central situation of these endothelial cell columns it may be inferred with certainty that they are derived from the proliferation of the lining endothelium of a lymphatic vessel. We see, then, that an endo-lymphangitis is present in areas shortly to be invaded by the centrifugal spread of obvious lupus. In the superficial layers of the subjacent dermis, lines of similar endothelioid cells, often solid, but sometimes presenting a central lumen, can be seen. These lines show Y-shaped junctions and are arranged

in a retiform manner. The appearances are just like those seen in an injected specimen of the skin lymphatics, and there can be no doubt that they represent an endo-lymphangitis of the dermal lymphatics, for their continuity with the undoubted central lymphatics of the papillæ can sometimes be traced.

Passing on, we note that the papillæ begin to show hypertrophy, and that around

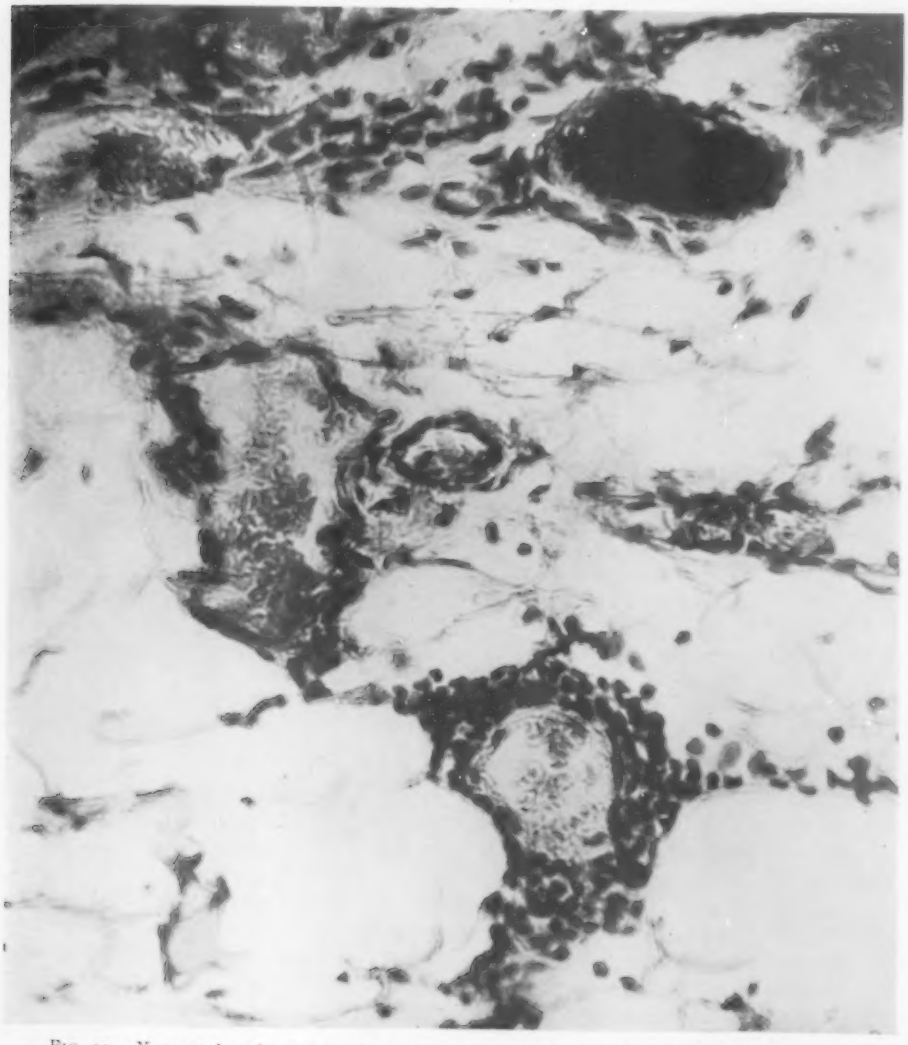

FIG. 11.—X 400 taken from the subcutaneous tissue in a case of non-ulcerative lupus shows a normal blood-vessel surrounded by a sleeve of tuberculous granulation tissue. This granulation tissue is probably formed by the infection and destruction of the comitant lymphatic of the little blood-vessel. Subsequent fibrosis of this granulation tissue cannot occur without strangling the blood-vessel.

the retiform columns of endothelial cells collections of inflammatory round cells begin to appear. They form a definite band in the superficial layer of the dermis just like that seen in Paget's disease and in elephantiasis. This plane of the dermis is the plane of primary confluence of the lymphatic capillaries, and the concentration of the round-celled infiltration in this layer and in the papillæ is an additional proof that the disease is a lymphangitis. The round-celled infiltration appears to arise from the inability of the leucocytes brought by the blood-stream to pass away along the blocked lymphatics.

In the deeper dermis accompanying the blood-vessels are lines of round-celled infiltration and epithelioid cells. Since lymphatics are comitant to blood-vessels the nature of these appearances is clear. (Fig. 4.) They represent lymphatics blocked by lymphangitis and surrounded by round cells which find their natural way of return cut off. We now reach a region of great papillary hypertrophy in the centre of the lesion where the papillæ and the superficial third of the dermis are converted into granulation tissue containing giant cells. These giant cells tend to follow the line of the lymphatics in a very definite way. Sometimes a line of giant cells can be seen occupying the situation of a lymphatic in the centre of a papilla. (Fig. 5.) At other times a vessel with proliferating endothelium but with a lumen still distinct can be seen to tail off into a line

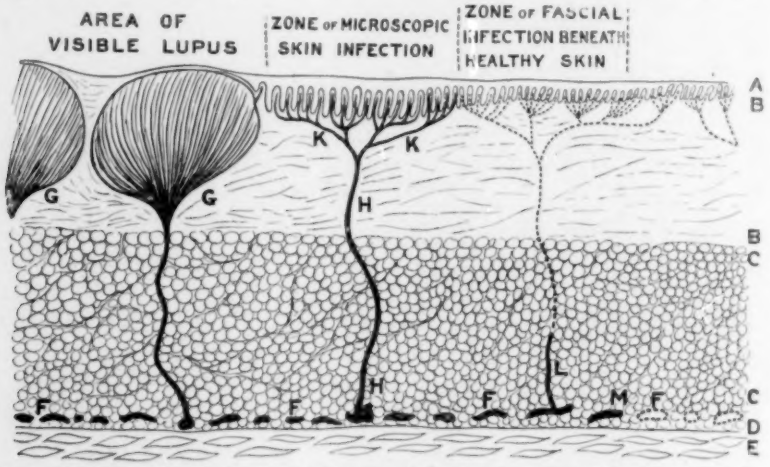

FIG. 12.—Schematic vertical section of the growing edge of an area of lupus. From above downwards the epidermis A, dermis BB, subcutaneous fat CC, deep fascia D and muscle E are seen. The disease is spreading from left to right. At the right edge the normal lymphatic system of the skin is represented by dotted lines. Just under the epidermis are the papillary end-sacs, uniting in the superficial dermis (plane of primary confluence) into small lymphatic vessels, which again unite to form vessels piercing the dermis and emptying into FFFF, the fascial lymphatic plexis. At the left edge of the figure are two primary lupus nodules, each formed by the destruction of an aborisation of lymphatic vessels. The lymphangitis has spread along FF, the fascial lymphatic plexus towards the right, and has re-ascended the vessel HH to produce early infection of its arborisation KK. It is also beginning to ascend the remoter vessel L. In the deep fascial plexus it has spread beneath healthy skin to the point M. The secondary confluence of the lymphatic vessels just deep to the skin is omitted for the sake of simplicity. Reproduced from the author's paper in "The Lancet," November 26, 1921.

of giant cells which follow the line of the original lymphatic. (Fig. 6.) These appearances leave no doubt that the giant cells arise from the proliferated endothelium of a lymphatic vessel.

We have not yet considered the appearances found in the subcutaneous tissue beneath the skin. They are scanty but very significant. In the perivascular tissue accompanying a small artery and vein, may here and there be seen linear collections of granulation tissue containing an occasional giant cell. (Figs. 7 and 8.) From their situation we infer that these appearances result from the tuberculous infection and subsequent destruction of a comitant lymphatic. Infection of the subcutaneous lymphatics in lupus is not a rare phenomenon, and has been frequently recorded by Leloir and others. Here is evidence that *lupus is not confined to the skin, and is not, properly speaking, a skin disease at all.* The skin provides a portal of infection and a rich lymphatic plexus in which the initial stages of the disease are located, but the subcutaneous lymphatics are soon infected.

Infection of Fascial Plexus.—Infection of the subcutaneous lymphatics certainly implies infection of the fascial plexuses into which they run. Though in this case I cannot demonstrate it histologically, it was sufficiently shown by the clinical presence of lymphangitis of the trunk lymphatics. If, as I maintain, infection of the fascial plexus is constant in lupus, the intractability of lupus to treatment aimed at the diseased skin is easy to

understand. The scraping or even the excision of the diseased area of skin is merely the equivalent of mowing a bed of nettles, for the roots of the disease—the infected lymphatics of the subcutaneous tissue and the deep fascia—remain untouched to reproduce it.

CASE II.—The second specimen was a small patch of lupus, about half an inch in diameter, on the upper arm of a little girl. It had apparently been ulcerated, but when excised it presented a central scarred area surrounded by a collarette of slightly raised, reddish, sub-epithelial nodules. I shall only describe the appearances found in the visible patch of lupus by saying that the papillæ were much hypertrophied, and that from the centre of some of the papillæ lines of granulation tissue representing destroyed lymphatics passed down to fuse with the subjacent lupus nodules composed of similar tissue. Some of the nodules tailed off below into stalks of granulation tissue running with the blood-vessels. Both these facts point to the origin of the nodules by proliferation of the related group of lymphatic capillaries.

FIG. 13.—Lupus of nose, showing hypertrophy of the papillæ and their obliteration by rational lateral pressure. Slide kindly lent by Dr. Ernest Shaw.

We now pass to the conditions found at the growing edge beneath apparently sound skin beyond the furthest lupus nodule. From the granulation tissue "stalk" of this nodule a side branch of granulation tissue passes out obliquely and can be traced right up to a papilla of the adjoining skin, into which it is prolonged. Thus a Y-shaped arrangement is seen, the left limb thick and formed of typical lupus tissue, the right limb slender and represented by a chronically inflamed lymphatic. (Fig. 9.) The whole arrangement is a diagram showing how a lupus nodule arises. The left half is completed, the right half is an outline drawing. The process is evidently spreading from the depth to the surface, for several of the skin papillæ within the area of the Y are normal and show as yet no lymphangitis. Further away from the edge, V- or Y-shaped cords of granulation tissue occur at fairly regular intervals in the superficial dermis over a distance of about one-tenth of an inch. Some of the skin papillæ are healthy, others show lymphangitis. This would not be the case if the disease were spreading in the plane of the papillæ. A fortunate section in this region shows one of the infected dermal lymphatics opening out like a stag's antler into about half a dozen infected lymphatics of origin which can be traced right into the centre of the papillæ, and their character of lymphatics thus proved. (Figs. 10 and 10*a*.) This particular section is a complete demonstration that in its early stages, before the picture has become blurred and confused my unlimited proliferation and nodule formation, lupus is a lymphangitis. We have before us not a complication of lupus, but lupus itself in the initial stage. Beyond this point the evidences of infection become indistinct, but they can be traced in skin papillæ situated one-eighth of an inch from the visible edge, and possibly a little further. Hypertrophy of the papillæ could be traced about the same distance.

Evidence of Subcutaneous Infection.—The condition of the deep fascia could not be directly investigated, but its lymphatics were certainly infected, for tuberculous lymphangitis of the trunk lymphatics was present. Cords of granulation tissue were found round some of the small blood-vessels in the subcutaneous tissue. (Fig. 11.)

CASE III.—The third specimen investigated was a strip of tissue excised beyond the growing edge of a case of lupus erythematosus. I shall not detain the reader with the histology of this specimen. Papillary hypertrophy is absent. It showed upon the deep fascia a quarter of an inch beyond the furthest point of disease in the skin, a cord of round cells accompanying a blood-vessel. This case provides distinct microscopic evidence that the disease spreads in the fascial lymphatic plexus. I found similar evidence in another specimen of lupus in the forearm, but the evidence of disease in the deep fascia is scanty and difficult to get, for excised specimens rarely include this layer. To conclude the evidence justifies the conception of the nature and spread of lupus embodied in the diagram. (Fig. 12.)

FIG. 14.—Warts on the hand of a healthy boy of twelve. Note the Y-shaped lines which suggest a lymphangitic origin for warts.

Artificial Production of Lupus by Intradermic Injection in Rabbits.—If a very fine needle connected with a reservoir of injection fluid is introduced into the dermis, the lymphatics in the neighborhood are generally filled by the injection fluid. This is the usual method for demonstrating the lymphatics of the skin. If a suspension of virulent tubercle bacilli is used as the injection fluid, then if my hypothesis as to the nature of lupus is correct, an area of lupus should appear after an interval at the focus of injection.

Having overcome the many obstacles which our laws place in the way of such experiments, and having obtained by the courtesy of the Lister Institute a suitable culture of bovine tubercle, I made a series of intradermic injections upon rabbits. The skin was previously shaved and cleansed. The injection produced a small local cutaneous induration which disappeared in a few days. I have unfortunately lost the detailed notes of these experiments.

In several rabbits no infection occurred but in the majority, about three

weeks after the injection, the cutaneous induration reappeared and slowly extended in area. It was indolent and not tender or inflamed. As it extended, a central area of ulceration made its appearance. In one rabbit enlarged glands appeared, and the animal died, apparently of general tuberculosis. The others were killed at various periods after the injection.

The clinical course of the experimental lesions left no reasonable doubt as to their tuberculous nature. Histologically, the appearances presented did not closely resemble those of human lupus, though the dermis superficial to the panniculus carnosus was greatly thickened by necrotic granulation tissue. These anomalies may be merely an index to differences between lymphatic arrangements of the skin of man and those of the rabbit. It would seem desirable that these experiments be repeated on an animal more nearly allied to man, as the chimpanzee. The fact remains that by injecting tubercle bacilli into dermal lymphatics of the rabbit, I was able to produce a chronic indurative and ulcerative tuberculous process, closely allied to lupus in man, and probably identical with it in all essentials.

FIG. 15.—Lupus carcinoma of face, September 19, 1920.

Why Does Lupus Cause Papillary Hypertrophy?—It is generally recognized that lupus of the non-ulcerative variety tends to assume a warty character, and when this character is prominent the name *lupus verrucosus* is applied to the lesion (Fig. 13.) I am not aware that any attempt has been made to explain why, if it does not ulcerate, lupus tends to assume in many cases this warty character. I shall be able to show that if lupus is a tuberculous lymphangitis, and if there is no ulcer present to drain away the tissue fluid, papillary hypertrophy is a likely sequel.

It is certain that obstruction to the lymphatic return is the commonest cause of the hypertrophy of the papillæ, which is the principal characteristic of warty lesions. The tendency to papillary hypertrophy will, however, be greatly increased if at the same time there is venous congestion and consequent increased transudation of fluid from the blood-vessels.

Obviously a proliferative lymphangitis of the papillary lymphatics, such as is seen in Fig. 2, will bring into play the first of these factors. That the second factor, venous congestion, is present, would appear from the reddish color of lupus nodules. The presence of congestion appears to be determined by the pressure upon the veins of the skin and subcutaneous tissue of cords of granulation and fibrous tissue which may be seen to accompany and surround them. (Figs. 7, 8 and 11.) The origin of these strangling envelopes of fibrous tissue around the veins is easy to explain. It has been shown that most small veins are accompanied by one or two lymphatic vessels. When these lymphatic vessels become the seat of a tuberculous lymphangitis, they are converted into cords of granulation tissue which as it changes into fibrous tissue contracts and presses upon the closely adjacent vein.

FIG. 16.—The same case January 1, 1921, after radium treatment. The growth has disappeared.

Why Does Lupus Cause Ulceration and Caseation?—This process has a result of even greater importance. The contracting fibrous tissue may not only impede the vein, but as its pressure increases it may strangle the small artery which accompanies it. The result is a failure of nutrition, a tissue necrosis, in the area supplied by the artery. This factor, and not the direct toxic action of the tubercle bacillus, is probably the reason why tuberculous lesions have such a strong tendency to ulceration and caseation.

Are Ordinary Warts Due to a Local Infective Lymphangitis?—In passing I may remark that it seems very likely that the multiple warts so often seen on the fingers of otherwise healthy children are due to attacks of lymphangitis, the result of otherwise abortive inoculations with the tubercle bacillus or some other organism. The photograph (Fig. 14) of warts on the hand of a healthy boy of twelve, shows the lesions arranged in lines

with a V-shaped junction. It seems likely that these lines represent the course of infected lymphatic vessels. The subject seems to ask for investigation, and I hope it may interest some reader of this paper.

Treatment.—In a Hunterian lecture in 1921 I expressed my general views on the treatment of lupus. Since I have seen no reason to modify them, the succeeding section of this paper is a transcript from that lecture.

It is in the surgical treatment of lupus that my observations seem for the present to find their practical application. It is very necessary to recognize the existence around the apparent area of lupus of a zone of apparently normal but really infected skin. Even in the chronic forms of lupus, this zone appears to be present. The knife of the surgeon must, if possible, circumscribe this area if he wishes to avoid recurrence. Even more important is it to recognize the fact that excision of the skin alone is an irrational procedure. It is almost certain that the underlying area of subcutaneous tissue is riddled with microscopic tubercle in the form of tuberculous lymphatics, and that a corresponding area of the lymphatic plexus upon the deep fascia is infected. Whenever possible, therefore—and it can be done in all cases of lupus of the trunk and extremities—an area of deep fascia at least as large should be taken away in one piece with area of skin excised. The test of the completeness of the removal is that muscular tissue should be seen in the floor of the resulting wound.

FIG. 17.—Lupus carcinoma of the nose.

Excision.—Leloir, writing in 1891, condemned the excision of lupus, though he admitted that in certain exceptional cases excision followed by skin-grafting might be the only means of cure. English surgeons have not shared Leloir's dislike for the method. Thus Cheyne and Burghard (1903) consider that an early patch of lupus should be removed by an oval incision followed by suture. For such cases they consider the method ideal. For more extensive cases they advocate, wherever possible, excision followed by

a plastic operation or by skin-grafting. The excision must be carried freely (at least a quarter of an inch) beyond the edge of the disease and well into the fat beneath, or it will not be successful. Doctor Whitfield who, as Dermatologist to King's College Hospital, no doubt had the opportunity of watching the cases operated upon by the authors quoted, shared their high opinion of excision in early cases and found relapse "extremely rare." On the other hand, after excision of extensive lupus followed by skin-grafting, relapse occurred within the grafts in the great majority of cases. There is here a clear indication of the defects of the present method of excision. Although the plane of excision traverses the deep subcutaneous fat, it leaves intact the subjacent infected lymphatic plexus of the deep fascia. The failure of excision conducted on these lines is an experimental proof of my contention that the deep fascial lymphatic plexus is the lurking place and main channel of spread of the disease. This contention is not vitiated by the almost uniformly favorable results of the superficial excision of very early lupus, in which presumably either the deep fascial plexus is not yet infected, or the inflammatory reaction of the operation suffices to strangle fascial infection in an incipient stage.

FIG. 18.—Lupus epithelioma occurring without previous radiation treatment in a woman of seventy, who had lupus erythematosus of Leloir since childhood, with double ectropion. An active edge of lupus still present on the right side of the face. Middlesex Hospital, October, 1920.

Is it possible to devise a method of excision which shall accord with the conception of the disease as a capillary lymphangitis? The answer to this question will vary with the site and extent of the disease, but for certain cases it is in the affirmative. Space will only allow me to describe the ideal

method; I must leave it to the individual surgeon to judge of its limitations for any given case. In any operation those pathological facts must be taken into account of which I have offered proof: (1) That lupus is a destructive proliferative lymphangitis, only confined to the skin in its earliest stage. If the area affected exceeds half an inch in diameter, it must be assumed that the subcutaneous tissue and the deep fascia are also infected. (2) That the disease is spreading in the deep fascia, not in the plane of the skin, and that accordingly the infected area of deep fascia is slightly larger than the infected area of skin. (3) That the visibly diseased area of skin is surrounded by a zone about a quarter of an inch wide in which microscopically tuberculous lymphangitis is already present.

Method of Operation.—The visibly infected skin must be circumscribed by a ring incision. In order to allow for the area of early microscopic lymphatic infection of the disease, this incision must not come within at least a quarter of an inch of the visible edge of the disease. The skin edges must now be reflected back for a further quarter of an inch. The exposed area of deeper subcutaneous fat is now surrounded by a ring incision which marks out the area of deep fascia requiring removal. This area is now raised from its edges towards its centre until the diseased area is removed. The surface of the muscles is exposed in the floor of the wound. The wound is now sutured or skin-grafted.

Obviously such an operation is impracticable for extensive lupus of

FIG. 19.—Lupoid wart, back of right hand and tuberculous lymphangitis of upper arm. Incision confined to upper area and glands. A skin grafted area is seen at the site of the present lesion. Subsequent recurrent erythema of forearm and part of upper arm. July 18, 1920, cord-like band leading to axilla from the erythematous area just in front of first wart, no doubt due to infection of collateral lymphatic circulation. This is represented by a dotted line. Above it is a dotted circle representing an infected gland.

the face. In lupus of the limbs or trunk it should be the method of choice, unless the disease is very extensive. Superficial excisions, not including the deep fascia, are only allowable where removal of the latter layer is impossible on cosmetic or other grounds. They should always be supplemented by cauterizing agents which it may be hoped will excite sufficient reaction to destroy the foci of disease in the deep fascia. Skin-grafting should be deferred until the cauterized surface has produced healthy granulations.

Bier's Hyperæmia.—We have seen that a passive hyperæmia with increased transudation is normally present in lupus. It seems improbable that the artificial exaggeration of this characteristic feature of the disease should exert a curative effect. It might indeed be argued that the repair seen in the older central area of a patch of lupus is due to hyperæmia. But the presence of hypertrophied papillæ beyond the visible edge of the disease makes it probable that slight venous obstruction is present in the earliest stage of infection, and, obviously, it does not interfere with the evolution of the disease. The conclusion is justified that artificial passive hyperæmia is most unlikely to arrest the spread of lupus, and it is worthy of note that Bier has ceased to employ this method. He states, "With congestion hyperæmia by bandage, I have seen no results, or only transitory improvement, of ulcerative lupus of the extremities."

Finsen Light Treatment.—Since sunlight is a notorious enemy of tubercle, it is not surprising that the Finsen arc lamp, which supplies light rays deprived of their heat, has a curative effect on the cutaneous manifestations of lupus. It is instructive to note that the method is ineffective unless the surface acted upon is blanched and made transparent by the pressure of a quartz disc. Even when this is done the light rays can only be expected to penetrate to the superficial layers of the dermis. In other words, the action is a surface action. The superficial nodules disappear, leaving a good scar, but the results obtained are rarely permanent, though the treatment is prolonged, tedious and expensive. If, as I have tried to prove, lupus is a capillary lymphangitis affecting the lymphatics of the subcutaneous tissue and the deep fascia as well as those of the skin, the failure of the Finsen light method to fulfil its early promise is easy to understand, for it cannot reach the deep fascia. It should be abandoned for methods more rational and effective.

Radium Treatment.—In the report of the Radium Institute for 1919, Dr. Hayward Pinch states regarding lupus vulgaris: "Cases of long standing which have proved non-amenable to Finsen light X-rays, CO_2 snow, scarification, caustics, etc., are sometimes quickly and effectively cured by radium, and the treatment is well worthy of a trial when other methods have failed." It is advised that ulcerated areas should receive an unscreened exposure of one and one-half hours, while indurated and non-ulcerative areas are best treated with long-screened exposures. The screen should be 1 mm. silver or 2 mm. lead. It seems probable that the future will see an extension of radium therapy in lupus as the method of choice. Apart from its direct action on the tuberculous tissue, radium is known to have the power of exciting

an aseptic lymphangitis, and in this way by obliterating the normal lymphatic vessels around the infected area, it may prove competent to stop the progress of the disease by erecting around it an insuperable barrier. To those radiologists interested in the surface application of radium, I would suggest, as the best means of erecting such a barrier, an encirclement policy working from the sound tissues towards the diseased area on the lines of the radium technic which I have advocated for carcinoma. It must be recognized, too, that the layer to be effectively irradiated is the deep fascia, not merely the skin, and to this end gamma radiation from screened appliances must be employed. Treatment must be guided by microscopic conceptions, not by clinical appearances, and must be mainly directed to the invisible growing edge, to the neglect at first of the visible lesion. A rationally planned course of radium treatment on these lines should be more effective than the purely empirical treatment hitherto employed. To see lupus as it really is, it is necessary to shut one's eyes, and to use the scientific imagination.

LUPUS CARCINOMA

There are some who believe that lupus carcinoma is an artificial product of X-ray therapy. This is a delusion, for the disease was recorded long before the discovery of X-rays, and two out of three cases which I have met with had never had radiation treatment. Devergie described the two earliest recorded cases as long ago as 1857.

Asihara ‡, who has made the best study of the subject, finds that on the average the interval between the onset of lupus, and the onset of the carcinoma, is about thirty years. The shortest duration before the onset of carcinoma was four years, the longest fifty-five years. It is very interesting to note here how slow the cause of cancer is in producing its effect.

The seat of election of this disease, as might be expected, is the face and particularly the cheek. Ninety per cent. of the cases occur on the face and 44 per cent. on the cheek (Asihara). Among 122 cases, 86 males and 36 females, Asihara found eight cases in which there was more than one growth. In several cases it occurred on both cheeks, and this is not surprising in view of the symmetrical distribution of lupus erythematosus. The youngest patient was a girl of nine. It most frequently occurs between the ages of forty and fifty. The lupus is usually of the ulcerative variety, and in only eight cases did it follow lupus erythematosus. My own case in which it followed this form of lupus, showed a carcinoma on the left cheek and a papillomatous elevation, doubtless a precancerous condition, on the right cheek. The disease appears rarely to follow lupus of mucous membranes. Asihara found four such cases, two in the larynx, one in the mouth and one in the œsophagus.

The disease exhibits a curious combination of intense local malignancy with absence of power to disseminate. Its local growth is rapid, and it

‡ Asihara: Ueber das Lupus-carcinom. Archiv für Dermatologie und Syphilis, 1901, pp. 193–234.

ulcerates also with great rapidity, soon leading to extensive tissue destruction. It is difficult to eradicate by operation, but one of the cases I shall record was caused by radium treatment.

It rarely leads to metastasis, and Asihara found the glands infected in only 16 out of 122 cases. My dermatological colleague, Dr. Henry MacCormic, has noticed the same peculiarity in the carcinomata which arise upon the scars and edges of chronic ulcers of the leg. These growths also do not disseminate. The view of the pathology of lupus which I am bringing forward in this

FIG. 20.—Patch of lupus (not included) close to internal condyle. Centre exhibit and scarred edge finely nodular, slightly varied and approaching the apple-jelly stage. In centre of arc a tuberculous gland lying close to the intermuscular septum. It proved to be caseous. Here an abcess had formed and discharged. In the axilla a discharging sinus with a pair of enlarged glands. Operation September 15, 1920. Monobloc dissection. Glands enlarged right to apex of axilla

paper provides for the first time a natural and simple explanation of the failure of these growths to disseminate in spite of their malignancy. I submit that in both instances the failure of dissemination is due to the previous obliteration by the disease of its usual channels, the lymphatic vessels. In the case of ulcers of the leg, it is highly probable that the adjacent lymphatics are obliterated by recurrent attacks of septic lymphangitis.

Lupus carcinoma should be suspected in any area of lupus which displays unusually rapid ulceration, or when local elevations appear rapidly on the surface, especially if they are indurated. If the edge of the ulcerated area is hard and rampant-like or everted, little doubt can remain. In some cases, however, the malignant tissue is surprisingly free from induration. Fortunately, there is no need to rely upon doubtful clinical indications, for excision of a small piece of the suspected tissue for microscopical examination can usually be made without an anæsthetic.

In regard to treatment, no dogmatic statements can be made. Asihara records nine records of cure among 122 cases. Free excision by the knife would not appear to be the ideal method, at any rate, it is frequently followed by recurrence. The surrounding lupoid tissue is badly nourished, and will not heal well, and probably some of the recurrences are due to implantation of malignant cells upon the raw surface. Diathermy seems to be the method of promise in these cases, but I have not yet had the opportunity of trying it. My own case shows that radium may be successful, but the price paid for cure in this case was high, namely, the loss of an eye and necrosis of the malar bone. I append brief records of two of my cases, with illustrations.

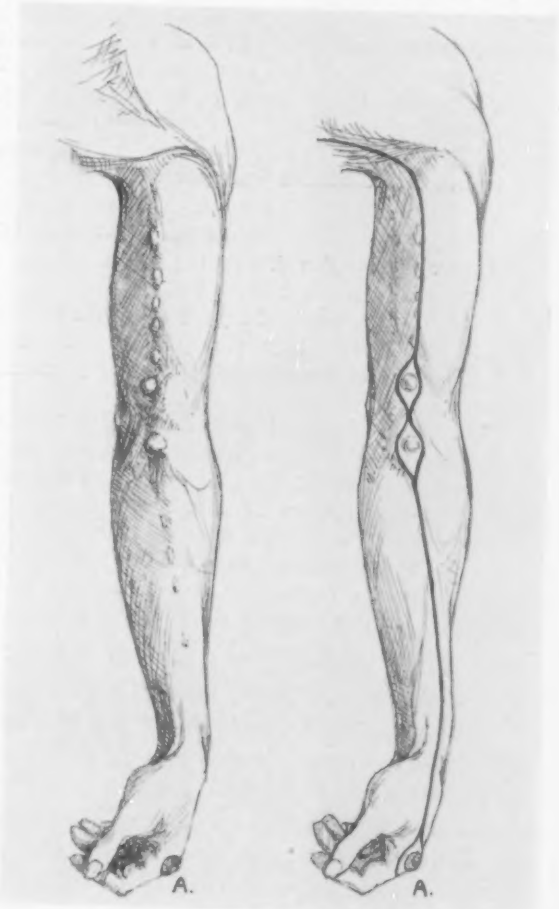

FIG. 21.—Disseminated lupus of the upper extremity in a man of 47 (E. M.). A is the primary patch of lupus. The black line in the right hand is the operation incision. Drawn by Miss D. Clephane.

Eliza M., *æt.* sixty-one, was admitted to the Middlesex Hospital under my care on September 17, 1920. She had suffered in childhood from tubercle of the wrist and foot, but these lesions were quiescent. When she was six years old she had "a large discharging lump" on both sides of the face. Crusts continually formed on the surface and came away. After treatment by hot fomentations the lumps were lanced. They disappeared after two years, leaving ectropion of the lower eyelids. In January, 1920, she scratched her left cheek with a comb. A crust formed, and a caustic was applied by a doctor. Soon after a lump formed, and rapidly increased in size, giving rise to discharge and pain.

Condition on Admission.—The face presents the typical symmetrical scarring of lupus erythematosus. There is ectropion of both lower lids and the nasal cartilages are shrunken and deformed. On the left malar region is an ulcerated indurated elevation about 1½ inches in diameter. It extends to the outer canthus, and is raised about an inch above the surrounding surface. (Fig. 15.) The patient has never had radiation treatment. There are no enlarged glands.

Upon the right cheek in a corresponding position are one or two papillomatous elevations.

This case was treated by intense and prolonged surface radiation with radium.

When she was seen in January, 1921, the growth had entirely disappeared (Fig. 16) and it has not recurred (Nov., 1924). Unfortunately, however, the left eye could not be adequately protected from radiation, since the growth was so near to it. A destructive inflammation of the globe ensued, and upon the advice of my colleague, Sir Arnold Lawson, the globe was removed. This did not end the patient's troubles, for necrosis of the underlying malar bone supervened for which the patient is still under treatment. It seems likely that excision of the growth with the knife and chisel would have given a better result, but at any rate the patient was cured of her disease.

A second case of lupus carcinoma supervening upon lupus erythematosus came under my care in 1920. The patient, William T., showed typical active lupus erythematosus, perfectly symmetrical, extending back as far as the ears and downwards to the chin, only the point of which was free from the disease. The nose showed a ragged cavity, rapidly ulcerating, the edges of which were remarkably free from induration. (Fig. 17.) A microscopic examination showed squamous epithelioma. The glands were not enlarged. An attempt was made to excise the growth, but it recurred far back in the bones of the nose and further treatment was abandoned.

DISSEMINATED LUPUS

Tuberculous lymphangitis of the vessels of the limbs may sometimes follow accidental inoculation of the tubercle bacillus. In some cases a patch of lupus, or a tuberculous wart or ulcer marks the point where the bacillus entered, or a sinus in connection with a tuberculous bone or joint may be the source of the subcutaneous infection.

Dobson § gives the following admirably concise description of the course of the disease:

"The affected vessels become thickened and obliterated by cellular proliferation; a perilymphangitis occurs, and in time definite tuberculous nodules form in the course of the affected vessel, which break down, invade the skin, and discharge, leaving a tuberculous ulcer. The thickened vessels can be felt under the skin between the nodules and running upwards towards the nearest group of glands, which are frequently enlarged. . . . . Lymphangiectasis has been noted in some extensive cases of tuberculous lymphangitis, cysts forming in the skin as a result of obstruction of the larger vessels; these may rupture and discharge lymph perhaps in considerable quantities."

It may be added that in some cases the affected limb becomes much swollen by solid lymphatic œdema, and that in the case of the upper limb phthisis beginning on the same side is a frequent sequela.

The name "tuberculous lymphangitis" is perfectly appropriate as applied to these cases, but if my contentions are correct, they have no exclusive right to it and no better right than the smallest patch of lupus. I suggest for these cases the distinguishing name *disseminated lupus*.

It is extraordinary how close is the resemblance between the clinical course of an epithelioma beginning on the hand and of a disseminated lupus arising from a primary patch of lupus on the hand. Such a patch of lupus may give rise to a ring of satellite nodules, may produce nodules along the course of the trunk lymphatics, may cause enlargement of the bicipital, axillary and supraclavicular glands and may finally attack the corresponding lung. An epithelioma does exactly the same things. On the contrary, either lesion may remain purely local.

These resemblances are the more remarkable because the essential pathological processes of carcinoma and lupus are wide as the poles asunder.

§ Choyce's System of Surgery, 2nd edition, vol. iii, p. 175.

Carcinoma is a new growth, lupus an infective inflammation. The only points common to the two processes are that both spread by the lymphatic vessels and that their extension occurs by continuity along the lymphatic vessels by permeation in carcinoma, by continuous infection in lupus. Embolism of either carcinoma cells or tubercle bacilli may occur in the trunk lymphatics, and to this extent only is the spread of either disease discontinuous.

The mere fact that both diseases use the lymphatic system as a highway forces their clinical appearances into the same mould. No better proof of the importance of lymphatic anatomy to the pathologist and clinician could be asked for, and a revival of the study of this neglected subject is much to be desired. I venture to predict, for instance, that the pathology of skin diseases in general will undergo a radical revision when it is correlated with the lymphatic anatomy of the skin.

Treatment of Disseminated Lupus.—It is generally agreed that the treatment of disseminated lupus should be by excision of the primary focus, the affected vessels, and the enlarged glands. The points to which I would here draw attention are two in number: (1) The possibility of carrying out this program with success, even when the necessary incision is over two feet in length; (2) the importance of the monobloc method of operation, *i.e.*, of taking out all the affected tissues—primary focus, vessels and glands in one piece just as if the operation were being performed for malignant disease.

I can best illustrate these points by giving the record of three personal cases. The first of these has already been published with colored illustrations in the British Journal of Surgery (January, 1920). The third case illustrates the penalty of violating the principle of monobloc operation. It also suggests that the future of operative surgery in the treatment of disseminated lupus may be a short one, for X-ray treatment controlled the recurrent disease, and it appears quite likely that since the disease lies so near the surface, improved radiation methods may supercede the surgeon entirely.

Tuberculous Lymphangitis following Injury to a Tuberculous Wart of Long Standing; Complete Excision in Continuity of Primary Focus, Infected Vessels, and Glands.—E. M., age forty-seven, a piano-maker, for many years had two small warts on the knuckle of the left index-finger. A sister had died of tuberculosis. In April, 1916, he accidentally cut one of the warts with a saw. Slight inflammation followed, and a few weeks later he noticed a small firm swelling under the skin, situated on the dorsal aspect of the lower end of the radius. In January, 1917, he attended Doctor Pringle's out-patient clinic. Tuberculosis of the skin was diagnosed, and he received X-ray treatment, but further swellings appeared up the arm, and Doctor Pringle advised surgical treatment. He was admitted under my care on April 20, 1917.

On admission, a patch of dry warty lupus, not ulcerated, and about an inch in diameter, was present on the knuckle of the left index. In a line between this lesion and the axilla were numerous nodular swellings (see Fig. 18). On the flexor surface of the forearm were several small subcutaneous nodules, covered by normal skin to which they were not adherent. At the junction of the middle and upper thirds of the forearm was a larger fluctuant swelling, ½ inch in diameter, covered by adherent, reddened, and thinned skin. Just above the elbow, in the situation of the bicipital gland, was another swelling, also softening. Several small nodules were present along the inner side of the upper arm, connected by vague, cord-like subcutaneous thickenings. The whole

formed a chain of nodules from the primary lesion to the axillary glands, which were much enlarged, hard and not tender.

Operation, April 26, 1917.—An incision was made in the axilla, and the enlarged glands were dissected out without division of the trunks reaching them from below. The incision was then prolonged downwards along the whole length of the arm to the primary lesion, bifurcating where necessary to encircle the larger nodules and the patch of lupus. The nodules, the connecting lymphatic channels, and the primary focus were then dissected out in one strip, continuous above with the axillary glands. Included in the

FIG. 22.—Disseminated lupus in a child of six (Kathleen B.) A is the primary focus BA softening tuberculous focus in the line of the main lymphatic vessels. C,A breaking down tuberculous gland. D,A deeper tuberculous gland marked by a circle. Drawing by Miss D. Clephane.

strip were the infected areas of adherent skin over the larger nodules. The wound, which measured 25 inches, was then sutured. It healed by primary union. The patient returned to work as a munitioner.

June 2, 1917, he was re-admitted with a small abscess over the middle of the biceps on the inner side of the arm. It was completely excised, together with the infected skin over it. The wound healed by first intention, and he left the hospital on June 11.

In April, 1918, he noticed a warty growth at the side of the original lesion, probably because I had failed to excise the infected deep fascia beneath the lesion. He was treated by ointments, but the condition grew worse. He continued at work, but the warty patch spread, and in April, 1919, he came again to see me. He had a patch of dry warty lupus, two inches in diameter, at the site of the original lesion. One or two subcutaneous nodules, not adherent to the skin, could be felt on the front of the forearm. The lupoid patch was excised, and the area grafted from the thigh. The nodules in the forearm were excised. His general health has continued excellent throughout.

On section, the recurrent lupoid patch presented warty hypertrophy of the skin, with a tendency to downgrowth of the epithelial cell columns. The papillary region and the superficial layer of the dermis presented diffuse round-celled infiltration, and numerous dilated lymphatic and blood-vessels were seen. The lymphatic vessels showed in places partial obliteration of the lumen by proliferation of the endothelium. A few typical giant-cell systems were present.

This patient was well when last seen.

Disseminated Lupus Cured by Monobloc Operation.—Kathleen B., aged six, was admitted under my care at the Middlesex Hospital in June, 1920. For two years she had been attending the out-patient department for a patch of non-ulcerative lupus situated

on the inner aspect of the left arm about two inches above the elbow. This was connected by cord-like subcutaneous indurations with a mass of enlarged axillary glands. The bicipital gland was also enlarged. (Fig. 19.)

The primary patch of lupus was rounded in outline and about half an inch in diameter. It presented a central, flat, whitish, cicatricial area surrounded by a collarette of slightly raised punctuate, reddish, sub-epithelial elevations. It was not ulcerated. There was no pulmonary infection, nor were the supraclavicular glands enlarged.

June 15, 1920, I operated and removed in one piece the primary lupus and the infected lymphatic chain up to and including the axillary glands. The primary focus was surrounded by a ring incision, which was prolonged as a long linear incision along the medial side of the arm into the axilla. The skin edges were turned back a little way, not only around the primary focus, but also along the linear wound. A band of the deep fascia about an inch wide was thus exposed. At its edges it was cut through down to the surface of the muscle so as to isolate it from the rest of the deep fascia. It was then raised from below upwards, a few touches of the knife separating it from the underlying muscles. The infected bicipital gland was included in the mass, and also of course the primary focus. At its upper end it was left attached to the axillary glands. The operation was completed by dissecting out these glands and suturing the wound. The wound was washed out with zinc chloride, 20 grains to the ounce. A tube for drainage was left in the lower end of the wound, and the whole wound was stitched with horsehair. Dry gauze and wool were applied.

On the 19th of August, 1920, the patient left the hospital with the wound soundly healed.

Disseminated Lupus. Recurrence following Violation of the Monobloc Principle of Operation. Attacks of Lupoid Erythema. Disease at Present Quiescent.—Ernest P., aged thirty-five, butcher, was admitted to the Middlesex Hospital under my care on the 14th of January, 1920.

On October 31, 1919, he noticed an inflamed area on the back of his right hand, after a scratch caused by a bone in the course of his occupation. By December 12 it had entirely closed, and an apparently healthy scar remained, but on the 23rd a small lump the size of a pea appeared at the centre of the scar. It gradually increased until January 6, 1920, when he consulted his private doctor, who incised the lump. On the 6th of January the patient noticed three little lumps in his upper arm, and a day after there was an enlarged gland in the axilla. He had no pain.

On admission there was a wart-like protuberance on the back of the hand, surrounded by a zone of erythema and covered by a crust. The elevation was elastic and movable. The bicipital gland and several axillary glands were enlarged but not tender. In the right upper arm a line of indurated lymphatic trunks could be felt, but there were no nodules in the foreram.

On the 19th of January, I operated, clearing out the glands in the axilla and the bicipital gland, together with a broad band of deep fascia and lymphatics connecting them. The incision extended from the elbow to the apex of the axilla. The wart in the hand was then surrounded by a ring incision and was removed, together with a rather larger area of the deep fascia beneath it. The wound was skin-grafted. No sign of tubercle was found in the gland examined. Unfortunately the primary lesion escaped examination, but there was no reasonable doubt that it was tuberculous.

Some months later the patient came up again complaining of symptoms like erysipelas of the forearm. (Fig. 20.) His forearm was much swollen and covered with patchy erythema. There was no pyrexia. A small tuberculous gumma had appeared about the middle of the forearm, and some indurated cord-like lymphatics could be felt just in front of the scar of the former operation. These lymphatics led up to a small enlarged gland near the anterior margin of the axilla. I was very much afraid that there would be widespread recurrence of the trouble, but it subsided under X-ray treatment, and in November, 1920, there was no obvious sign of disease except a small subcutaneous infiltration on the forearm.

SPINAL ANÆSTHESIA*

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In recent days discussions have arisen on every side upon the subject of spinal anæsthesia. At Lyon several communications have already been made upon this subject. If one examines all of these works as a whole, one impression is clearly obtained. It is the following: that spinal anæsthesia is gaining ground from year to year. It is certainly the choice of the young surgical generation and of those surgeons a little preceding this. And it is just that fact which guarantees its future.

Personally, I have been faithful to it since 1910, when I tried it following the publication in the *Lyon Chirurgical* of a memoire of Violet and Fisher based upon 272 cases of Auguste Pollosson. I employ it now more and more, and actually I am using it in 75 per cent. of the operations having to do with the subdiaphragmatic part of the body. I may add that, like many other surgeons, I am constantly reducing my use of anæsthesia by inhalation; in the year 1922, of 420 anæsthesias for serious operations, I note 259 localized anæsthesias (local, regional truncular, or spinal), and only 161 anæsthesias by inhalation (118 with ether, 2 with chloroform, 41 with ethyl chloride). I believe that many other surgeons have similar ratios.

From the point of view of the surgeon, spinal anæsthesia is the ideal one: easy technic, analgesia in general perfect, little risk, absolute abdominal quiet, complete muscular relaxation, and simplicity of anæsthetic sequels.

Does this mean that it has no inconveniences, no risks? Certainly not. But if one is familiar with the laws of this mode of anæsthesia, one can lessen the inconveniences and suppress almost all of the risks. There are then these laws which it is necessary to study thoroughly, so as to discover the best means of observing them. I would like to do this, basing my study on a personal experience which, last October (1923), was the result of 3000 cases.

In this list I enumerate two deaths and three serious accidents.

The first death was observed after an anæsthesia with allocaine in the case of a man wounded in the war, having multiple fractures of the lower limbs and in a bad state of shock; the anæsthesia administered in a sitting position immediately aggravated the state of hypotension and the patient died after some moments. I have no doubt that this wounded man, who had a very low blood-pressure (six or seven measured by Pachon's method) would have died without spinal anæsthesia, but it is certain that this anæsthesia had an action manifestly aggravating; I concluded from this that spinal anæsthesia

* Read before the Société de Chirurgie, Lyon, France. (Translation by Beverly Douglas, M.D.)

should not be used in the case of shocked patients, although others have said differently. For me this is a formal contra-indication.

The second case of death observed occurred in the case of a man of sixty years, cachectic and desiccated, suffering from a stenotic neoplasm of the pylorus, very far advanced. After injection in the lower dorsal region with 13 centigrams of allocaine, there appeared after some seconds, a general insensibility with apnœa against which nothing would avail. This case was reported by Santy in the *Lyon Médical* in 1921, in an article on spinal anæsthesia. In this case I committed two faults: the first was to employ spinal anæsthesia in the case of a patient with low blood-pressure; the desiccation is identical with shock from this point of view; the pyloric stenosis, serious not so much in its cause as in its clinical translation, is a contra-indication to spinal anæsthesia. The second fault was to inject too strong a dose of allocaine: 6 or 7 centigrams would have been sufficient. In these two cases, the anæsthesia constituted the drop of water which made the vase overflow. It is necessary to draw a lesson from this experience, but these facts are in no sense chargeable against the spinal anæsthesia.

To-day, in a similar case, I would refrain from all spinal anæsthesia in the case of such patients. With the majority of those who have had actual experience with this mode of anæsthesia, I consider low arterial blood-pressure as a contra-indication to this form of anæsthesia.

I have observed three serious accidents. (1) In the case of a wounded man suffering from a crushing injury of the tibia caused by the bursting of a shell. The injection of 10 centigrams of novocaine instantly aggravated the state of shock, the pulse became imperceptible, the patient lost all consciousness, and it seemed that he must soon die; I waited for an hour and a half, meanwhile observing him on the operating table in a room especially warmed; at the end of this time, as there was no change in his condition, except for a slight amelioration of blood-pressure, and as it was necessary to finish, I did a very rapid disarticulation of the knee without anæsthesia; this had been done scarcely two minutes when the patient came out from his stupor with a long sigh, as from a dream, and declared that he was well and that he was sleepy. He then slept and in due course of time was cured without incident.

In another case I had to do with a puriform meningitis which was treated the same evening by Santy by repeated lumbar punctures and which was cured. This observation was published by Santy and Langeron in the *Lyon Chirurgical* in 1921. This same history was repeated in the third serious accident which I saw; *i.e.*, cephalic torpor, and slowing of the pulse; lumbar puncture recovering cerebrospinal fluid very strongly hemorrhagic. Cure.

In addition to this I have seen lipothymic states in the first quarter of an hour, with which everyone is familiar, sometimes with vomiting rarely persistent, with spinal pains, and above all with cephalies the frequency of which I would not know how to determine. These have never been very lasting since the time I thought of attributing them to hypotension of the spinal fluid

and I have treated them by injections of physiological salt subcutaneously during two or three days, or by an intravenous injection of distilled water.

I have not seen any paralysis of the lower extremities nor of the eye muscles.

I estimate the failures at 5 or 6 per cent.; I have not calculated the exact statistics upon this point; there were more of them at the end of the war and at the beginning of 1919 when the anæsthetic products were much inferior in quality; after that these products were regulated and good anæsthesias were again possible just as before this period. It is probable that all the failures which were not due to a bad quality of product were caused by little faults of technic, such as instances where the needle was too large and after its withdrawal part of the fluid escaped into the epidural space, or when its plunger, too large, remained riding upon the meninges and in the epidural space.

In conclusion, my experience with spinal anæsthesia leads me to say that it is a remarkable method of anæsthesia, without danger, except in the case of hypotensives, where it is formally contra-indicated, and that, in spite of these cases it is much superior to general anæsthetics whether for the patient or for the surgeon.

I know very well that there are contradictory opinions; that many surgeons still dread spinal anæsthesia; that there are still cases of death and of unfortunate occurrences; that recently at the *Société de Chirurgie de Paris* there were reported three deaths in 600 cases, three in 1000, one in 250, and that this furnishes cause for hesitation. But I think that most of the time accidents are due to poor understanding of the laws of spinal anæsthesia, of its technic, and of its contra-indications, and to ignorance even of the nature of the accidents which may be produced.

On the other hand, one will notice elsewhere among the accidents which have been reported that there is almost no case with autopsy and that an autopsy would be necessary to place the blame with certainty upon the anæsthesia. How, in fact, can one incriminate spinal anæsthesia after an exploratory laparotomy of the biliary tract, of the pancreas or of the stomach, when one does not even know if there are metastases? Further, when one discusses similar questions, one must always think of the story connected with Simpson. It is well enough known that on the day when Simpson was going to try the effect of chloroform for the first time in the case of a human being, the one who was carrying the flask slipped upon entering the operating room, fell, and the flask was broken and all the chloroform lost. As there was no more of it, it was decided to operate as usual, that is, without anæsthesia. Now it happened that when the incision of the skin was made, the patient had a severe syncope and died. Simpson, in recounting this story, added: "Chloroform had a beautiful escape." It is necessary, therefore, not to conclude too quickly to incriminate an anæsthesia without other form of procedure—that is to say, without autopsy. In this way one encumbers the

history of spinal anæsthesia with a mass of statements without value which are nevertheless capable of overwhelming it.

In any case it is sure that if one does not allow himself to have recourse to spinal anæsthesia in any hypotension, shock, inanition, etc., one almost never observes accidents. But out of principle one must not use it, and, it is wise to remark here that it is too often the reverse which is done; the surgeons who are not accustomed to using spinal anæsthesia think they ought to try it among the cachectic, icteric, ascitic, and among serious accident cases and shock cases; in fact, where in all reality it is contra-indicated and where anæsthesia with ether would be preferable. And very naturally they draw the most false possible impression of it.

It would then be legitimate, in such an instance, to incriminate only the case itself and not to blame a mode of anæsthesia erroneously employed.

As far as the little accidents and inconveniences of spinal anæsthesia are concerned, I believe that the same is true: most of them are avoidable, provided one really understands the laws of spinal anæsthesia. These laws, it should be published abroad, are generally very little known. Spinal anæsthesia has not had the good fortune of interesting physiologists which other forms of anæsthesia have had. Its experimental study has not been pushed thoroughly, and to speak truly, it is only through clinical observations, that little by little one has come to ferret out its fundamental characteristics.

The first of these is that it is a *regional anæsthesia;* strongly radicular, if one takes care of it, the action of the anæsthetic exercises itself solely on the intraspinal segment of the posterior roots in the region where the injection has been made. Thé diffusion of the anæsthetic to the anterior roots does not necessarily occur, as is generally thought.

One has formed the habit of injecting in the dorsolumbar region a dose of anæsthetic, more or less fixed, without regard to what has been going on. The mixture of analgesia and of motor-paralysis, ordinarily obtained, is considered as a constant and obligatory result, and many surgeons commence intervention only when the patient can no longer move. This is entirely erroneous.

If the anæsthetic is injected carefully, very carefully, if it is disposed of slowly to the surface of the cerebrospinal fluid, like red wine on water, there is obtained an analgesia localized only to a few roots, and the motor power remains unaffected.

When one wishes one can do the following experiment: Carefully inject the anæsthetic substance, operate without the perception of any pain, and, the intervention ended, ask the patient to raise himself for the dressing; one will see him very easily bridge his back; one might even have him descend from the operating table, if not for some fear of trying this experiment.

Just so if one gives a median-dorsal anæsthesia, proceeding with great gentleness, without trying to make the anæsthetic diffuse one obtains, for example, an anæsthesia purely abdominal. I have noted this several times,

and one knows that in the case of the high anæsthesias of Jonnesco, the phenomenon of the integrity of the lower segment of the body is constant.

This regional character of spinal anæsthesia is again noticed in the study of the mode of progression of the zone of analgesia. After the classical lumbar injection, the sensibility disappears first in the perineum and scrotum; then there appear tinglings in the heel; it is only after the disappearance of the sensibility at this level that the analgesia remounts then to the leg; it reaches the thigh only in the last stage.

It is then absolutely certain that spinal anæsthesia is a radicular regional anæsthesia. Without doubt, one can make it lose this character, but in my opinion, it is a mistake to try to take this away.

In order that this may not be lost, it is necessary to remember that the diffusion of the anæsthetic in the cerebrospinal fluid (and consequently the extension of the analgesia) is exactly dependent upon three laws of the diffusion of one fluid in another fluid in a closed vessel as follows:

1. *The diffusion is inversely proportional to the concentration of the solution injected:* with a hypertonic solution it is very weak; with an isotonic solution it extends to five or six roots; if one practices successive dilutions, drawing the cerebrospinal fluid in and out in the syringe, one increases it greatly, without utility.

2. *The diffusion is inversely proportional to the pressure of the cerebrospinal fluid.* The more of the fluid one draws out before injection, the more one facilitates the diffusion. This is useless. There is no advantage in letting 10 or 15 c.c. of fluid flow before injecting the anæsthetic, as is generally done. And this surely entails inconveniences.

One can notice furthermore that the best spinal anæsthetics are those in which one finds that the fluid has an elevated pressure. Having made this observation a long time ago, I have often been well assured of excellent anæsthesias, by making an injection of salt solution under the skin one hour before the anæsthesia.

3. *The diffusion is directly proportional* (other factors being equal) *to the speed of the injection.* If one pushes brusquely and forcefully the piston of the syringe, the diffusion is a maximum and instantaneous.

But is there any advantage in doing this and in obtaining a diffused anæsthesia after the fashion of Le Filiatre or of Delmas? I am absolutely persuaded that the contrary is true, and I ask myself can one draw any benefit from it? One would hardly say so; furthermore, it is easy to find inconveniences connected with this manner of doing it.

The technical conclusions of what I have just recounted are as follows: *To have a good spinal anæsthesia, it is necessary to seek to have a regional anæsthesia, and for that it is necessary to inject a solution slightly hypertonic or isotonic, to inject it gently, very slowly, without having made beforehand the least withdrawal of cerebrospinal fluid, and without drawing it in and out.*

But this technic does not yet suffice to abolish all the avoidable disadvantages. Until now, no technical precaution has had for its objective the

prevention of the lipothymic tendencies and syncopies which may be a danger and a disadvantage to spinal anæsthesia. In order to know what precaution to oppose to this risk, it is necessary to understand the mechanism of it. One generally considers the lipothymic state as the sign of a bulbar impregnation by the anæsthetic, that is to say, diffusion on a large scale.

I do not believe this to be exact. The bulbar phenomena of the first quarter of an hour in the course of a spinal anæsthesia are evinced not by the intoxication of the anæsthetic, but by a relative anæmia of the bulb. What proves it is that one may prevent them in great measure by placing the one anæsthetized at once in a position with his head down, a procedure which would, in bulbar intoxication, be the worst of remedies, since this position would favor, to a certain degree, the diffusion of the anæsthetic.†

It is on account of this that spinal anæsthesia can be prescribed in the case of patients in danger of syncope.

To what must we attribute it? To my mind, it is due to the fact that the anæsthetic, in blocking the sensibility, blocks the vasomotor conduction. One knows that the vasomotor nerves leave the cord in company with the anterior roots, except in the lumbo-sacral region, where there are numerous vasomotor elements in the roots.

Because of this fact, without doubt, and by a mechanism which we can divine but which has not yet been studied—for I do not think that a similar explanation has ever been proposed—spinal anæsthesia provokes a derangement of the vasomotor regulation from which results the anæmia of the nervous centres.

If we put aside low radicular anæsthesias, the best way to avoid the vasomotor derangement, produced by the anæsthetic, is to seek to localize the effect of the anæsthetic to a maximum degree in the posterior roots. In fact, it is in the case of the anæsthesias very much regionalized, by slow injection of the product, without drawing it in and out, that one most surely avoids the bulbar phenomena.

But once again the precautions above indicated may not be sufficient. There are some accidents depending on other causes, and here also one is generally subject to inexact notions.

It has been thought, and many still believe, that post-anæsthetic accidents, especially cephalies, depend upon the high pressure consequent to the introduction of a liquid into the subarachnoid spaces and to the meningeal reaction which would accompany it.

There is in that a false interpretation: a number of these accidents are, entirely to the contrary, due to hypotension. This depends generally upon the flow of the cerebrospinal fluid into the epidural spaces, along the track of the puncture needle. This track closes with great difficulty. It has been my lot to do laminectomies eight or fifteen days after a lumbar puncture

† The position of Trendelenburg favors experimentally and clinically the diffusion toward the head of liquids placed within the cerebrospinal fluid, and that is what makes it preëminent in therapeutics, tetanus for example.

and to find the track of the puncture still gaping, closed simply by non-adherent epidural fat. It sufficed to depress the dura-mater with the tip of a clamp, in order to see the liquid ooze the length of the plug.

Therefore, we may understand (and Sicard has already noted this) that the holes of the puncture lose fluid; the larger they are, the more numerous they are, the more abundant is the flow. This has many consequences.

It is therefore probable, at the start, that certain anæsthesias are made insufficient by the fact that the anæsthetic is thus lost in great part. It is certain in the second place that the cephalies are due to some hypotension; and in reality it suffices by intravenous injection of 40 c.c. of distilled water to raise the pressure of the cerebrospinal fluid in order to make these difficulties disappear. I believe that I am not alone in making this remark; the generalization of their treatment by the injection of distilled water is the best proof.

From all of this is evolved the following practical conclusion:

For the punctures, it is necessary to employ only trochars and needles of very small calibre, in fact, of the smallest possible calibre, with short bevel and the least traumatizing sort that one can procure.

It is in being attentive to these details which in appearance are insignificant, that one gives to spinal anæsthesia all of its value, and all the security which is needed.

Under these conditions spinal anæsthesia is the most innocent of the various modes of anæsthesia.

Does this mean that it is necessary to employ it for all surgery as Jonnesco does? I do not think so. For the head, the face, the neck and the thorax, the anæsthesia of choice is a combination of local and truncular-regional anæsthesias. On the contrary, for the abdomen, subumbilical region and lower members, spinal anæsthesia, in my opinion, is the procedure of choice. This does not mean that it should be necessary to abandon general anæsthesias. This would be absurd. But with the exception of special indications, personally, I prefer the spinal anæsthesia.

There remains the question of the superior part of the abdomen, the stomach and liver. I do not think that it should be necessary to reserve it totally for one exclusive mode of anæsthesia. A patient with stomach or liver trouble in good general health, without hypotension a patient who has neither a serious stenosis of the pylorus nor a nearby neoplasm with cachexia or jaundice, benefits by spinal anæsthesia. In the contrary case ether is, in my opinion, of greater value in spite of the risk of pulmonary complications which elsewhere vaccinotherapy sensibly diminishes.

On this account for this region I remain eclectic, and the facts which I have exposed above furnish the reasons for my abstention.

PYLORUS SPASM AND ITS SURGICAL TREATMENT

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Spasm of the pylorus is a very common diagnosis applied to stomach troubles of difficult interpretation. We should, instead of feeling satisfied with it, try to come to a better understanding of it by careful clinical, röntgenologic, and perhaps operative surgical study, in as much as in the present condition of our knowledge it would not be easy to answer to the question: does a primary pylorus spasm exist independent from any demonstrable organic lesion, and capable of producing important stomach troubles, and can it be efficiently treated by medicine or by surgery?

The so-called *reflex pylorus spasm,* as a consequence of lesions of the stomach, or of distant organs is generally admitted; at least many digestive troubles occurring during demonstrable diseases as for instance of the gall-bladder or of the appendix, can be explained by a condition of increased tonicity of the pylorus canal and pylorus ring, either by direct stimulus brought by continuity to the stomach wall, or indirectly by abnormal stimulus of afferent nerves of a diseased organ, which travelling to the nervous centres would bring back a response capable of inducing troubles in the secretion and in the motility of the stomach.

To explain through physiopathology the intimate process of such a supposed fact, would be not so easy. For the while we must admit its existence clinically, as we know that the removal of the primary lesion cures the stomach too.

We know less of *the primary pylorus spasm* of the adult. Nothing can be found in the adult which compares with the infantile spasm. It is not very unusual to see hypertrophy of the pylorus ring in the adult, but it is quite different from the infantile one. A section through the ring did show to me in some cases operated upon by me some years ago, with diagnosis of pylorus cicatricial stricture, a thicker wall than normally, and the lesion was not so extensive as in the baby, but quite limited to the pylorus, and the microscope revealed inflammatory changes, without ulceration or scar, so that it is perhaps better explained as a consequence of a localized gastritis. (Pyloritis.) Congenital conditions persisting through life have been described by Heidenhain, who thinks that the function is normally maintained by a compensating hypertrophy of the antrum, which could be insufficient in case the pylorus is spastic. These conditions are unknown to me and have been denied by others. (Gruber-Chiari.) The clinical and radiological symptoms of the indurated and thickened pylorus are exactly similar to those of the cicatricial pylorus stenosis, and there is no reason for thinking of a spastic condition.

The pure nervous spasm in neurotic individuals is generally admitted, as

it seems it must be a spasmodic condition in cases of duodenal or gastric ulcer. The radioscopic demonstration of more or less permanent pylorus closure during contractions of the antrum seems the best proof of its existence. But if such a closure yields after some time, and if finally the emptying of the stomach is complete in normal time or about, we should not give any great importance to such a fact, which being transient cannot bring definitive changes in the stomach function. But if the stomach has a marked delay in emptying notwithstanding normal peristalsis, we may assume that the closure of the pylorus is the real cause of the trouble. The interpretation of such a closure, if true spastic, or organic, excluding the classic advanced stricture of the pylorus, is not always easy. So that, even admitting the possibility of a primary pylorus spasm, its importance and its diagnosis, and its effects on gastric function are far from being well studied.

The reflex spasm as a consequence of hyperacidity is generally admitted, and the common theory is that the abnormal gastric juice secretion induces a closure of the pylorus.

Patients having the so-called hyperchlorhidria present symptoms of intense burning after meals, more or less prolonged and accompanied by epigastric pain, heaviness and retardation of stomach emptying.

Many patients can tell exactly the moment in which the stomach after a longer or shorter period of suffering, gets rid of its content, as if there had been an obstacle which finally has given way. Certainly the stomach tube and the Röntgen examination may reveal delay in the emptying, and an increased gastric secretion. Clinically we are brought to admit such a condition without any doubt, and surgical experience seems to confirm clinical observation, as in many cases no organic lesion can be found, but sometimes, not always though, a hard and perhaps thicker sphincter. These clinical observations were in harmony with the physiological doctrine that the chemical conditions of the stomach and duodenum contents were of the chief importance in pylorus function.

Researches of Cole on the movements of stomach followed by others, and especially those of Wheelon and Thomas, seem to be against a chemical doctrine. Quoting Macleod we may say that Cole finds a definite relation between antral and sphincter movements, whose activity is proportional to the antral contractions so that feeble antral movements go with low pylorus contractions, and the contrary; the chyme passes through the pylorus during stomach systole. Wheelon and Thomas besides confirming and extending such investigations have demonstrated that acidity or alkalinity produced in the stomach do not influence the regular phases of antral sphincter waves, and neither duodenal acidity prevents sphincter relaxation, nor its alkalinity does produce it. Very important is the demonstration given by them of the intimate relationship between movements of the duodenum, below the cap, and those of the antrum and sphincter and the conclusion that the duodenal motility influences the sphincter activity, and the motility of the stomach

influences the duodenal function. All together it seems that antrum and sphincter follow *the intestine law* and not a chemical influence.

In favor of such a view are also clinical facts, for instance that of no few patients suffering from hyperclorhidria who do not show at the fluroscope any sphincter spasm, as it is not always present with stomach or duodenal ulcer, and it may exist with ulcer and hyperacidity. Surgical observation too shows in such cases, when wrongly operated upon, not always signs of increased pyloric activity. The radiological observations and the late physiologic conclusions cannot be so simply accepted. There must be a great difference between the stomach duodenum functions under the influence of different natural meals, in various conditions of mind, body, and time, and especially in pathological local or general states, and the functions which we see after artificial meals or in artificially induced changes of the chemical function. I believe that we are not yet allowed to bring forth sure and definite conclusions.

As about *the pain* accompanying this disease or other troubles, without organic lesions, it is really very doubtful if the cause of it should be in the spasmodic contractions of the whole antrum incapable to win the sphincteric resistence, or in those of that muscle, or in the hyperæsthesia of the gastric mucosa, or in the nervous system. Many times we see through the fluoroscope very marked spasm without any pain, and in other painful cases there is vomiting of acid liquid and no marked spasm, so that we have matter for doubt.

The demonstration of a transient tremor in the epigastrium, as due to the spasm, seems to speak more for the tonic contraction of the whole antrum than only of the pylorus sphincter, and physiological observations are more in favor of a contemporary contraction of those parts. The presence of erosions or fissures in the pyloric mucosa is also commonly spoken of as a cause of a spasm of the sphincter, giving origin to very severe symptoms comparable to those of organic strictures or later leading to such one—Kussmaul and others have spoken of such irritable erosions, others of a catarrhal condition of pyloric mucosa leading to a stricture. As I said before, those narrowings of the pylorus independent from ulcers, have been found many times, and I have published such cases in 1893 and treated them with pyloroplasty, and later other cases too. But there was no spasm, and I have never found the so-called erosions or fissures after opening largely and carefully inspecting the mucosa of the pylorus and of the duodenum. A comparison with the fissure of the anus is consequently wrong, as such does not exist in the pylorus, and is wrong to the comparison of the anisphincter contraction in such cases with a pylorus spasm, when we do not know if it does exist such a morbid primary condition capable of producing severe pain and severe gastric troubles.

It seems to me that at the present the question of the pylorus spasm must be revised, and I present here certain clinical cases as a contribution, not with the hope of giving any solution of the problem, but only to show that surgery may perhaps lead here as in many other pathological conditions, to a better understanding of facts.

A publication of E. Payr (Leipzig) of November 1, has also induced me to such a contribution, for I have, independently from him, operated upon four cases since July 1, led by reasons much similar to his.

In every case of mine the accurate clinical study, and the Röntgen examination had brought me to the diagnosis of certain or probable duodenal ulcer, and in none of them was it found. Unfortunately such cases do happen rather often, not only to me, but also, I believe, to other surgeons, but publications of them are very rare. The reason must be not so much in the peculiar feeling of the surgeon after a useless operation, as in the doubt and in the uncertainty in which one is left, for even after a most thorough examination, one has always the suspicion of having left something behind either by one's fault or by the impossibility of seeing everything completely. At any rate, even having no doubts, I find that such cases are of difficult interpretation and difficult to bring under some definite heading. Since in some of my previous cases, as in the last four, the clinical diagnosis was not only made or accepted by myself but by competent medical men and in union with the hospital staff, I must conclude that with our present knowledge we have not yet learned to avoid such mistakes. In the previous cases, without definite lesions, even when the sphincter did appear hard or abnormally contracted, I did not perform any operation, as I have always done when the pylorus and duodenum were apparently normal, knowing the faults and damages of gastro-enterostomy in such patients. In the last four cases my attention to the pylorus ring was more attracted. As in all of them especially in the first it was really striking. And the idea of cutting it came easily, having in mind our experience in the infantile pylorus hypertrophy. I was not sure that this condition was the real cause of the gastric troubles of my patients, but I was persuaded that it could have some importance, and that the partial suppression of the pyloric function could make easier the stomach evacuation. If it is true that "the law of the intestine" is the true one,* then after the section of the pylorus, the antrum waves would be followed by a complete and strong contraction of the sphincter, and this would remain open for a longer period, allowing a better emptying of the antrum, and on the other side the duodenal influence on the sphincter would also be diminished. The idea of treating surgically the pylorus spasm, by pyloroplasty and by gastro-enterostomy is an old one There have been in Italy many such operations performed early by Carle, Novaro, Postemphy and others. Before 1895 when Doyen so strongly emphasized the importance of the pylorus spasm and its surgical treatment, though he believed that pyloroplasty was inferior to gastro-enterostomy. Payr in 1905 described pylorus spasm with pain, hyperacidity, hypersecretion in diseases of appendix and of stomach, even with symptoms of stenosis accompanied by

* Reviewing the tracings obtained by me in experiments made many years ago (Moleschott Untersuchungen, Bd. XIV) by introducing small rubber bags in the fundus and in the pylorus, I see that normally it is really so, that is, the waves beginning in the fundus do travel to the antrum and to the pylorus which contracts almost immediately after them, and opens for a while when the antrum is still contracting.

vomiting and with demonstrable tumor due to the contracted pylorus, and for this condition he recommended pyloroplasty. E. Starr Judd and Fred W. Rankin have in August, 1923, reported on excision of duodenal ulcers followed by the addition of the Rammstedt technic of simply incising the muscle fibres of the pyloric ring at right angles to the opening, when the pyloric muscle seemed more spastic than normal, and they found this procedure advantageous.

In all my cases the operation was easily performed, and it seems useless to speak about its technic. I must only say that I could not always prevent the production of a small opening in the duodenum, whose structure is such that it does not allow any separation of the muscularis from the submucosa, so that in performing the Rammstedt operation it is better not to extend at all the incision to the duodenum, but more towards the antrum, so that not only the ring but also fibres of the pyloric channel may be cut. The small opening in the duodenum assumes a triangular form, and its reunion is simply made in a transverse direction by few very fine catgut stitches catching the pylorus submucosa and the duodenal serosa.

A small flap of fat either pedunculated from the hepato-duodenal ligament or free from the omentum was always introduced between the lips of the section after having detached the muscular layer from the submucosa in such extension as to be sure that the cut ends of the sphincter would freely retract.

The results have been so far good. I have seen again the first three cases before publishing this note, and in every one the symptoms until now have disappeared, and the Röntgen examination has shown no difference from normal in the evacuation of the stomach, in the form of the pylorus and in its function.

It is impossible to judge after a short time as we know well the fluctuations of such troubles, and a long experience only will give us satisfactory documents.

I have not tried with this note to resolve a question; far differently, I have put a question: Is the primary pylorus spasm such an entity that we can diagnosticate it clinically, and during an operation? And are there conditions which can be benefited by cutting the pylorus ring? Can we through such an operation by the Röntgen and clinical or perhaps experimental study gain a better understanding of those conditions?

Here are the cases in short:

Case I.—T. A., male, twenty-four years of age, enters the first pavillon of the Policlinico on the 24th of June, 1924. He suffers since 1918 acidity and heaviness in the epigastrium, one and one-half hours about after meals, which ended with the completion of the stomach digestion in about four hours if left alone—and quicker using alkalines. Heaviness and acidity forced him sometimes to induce vomit. He was relieved by small quantities of food, after one year the constrictions have grown worse; he has pain radiating to the spine—the burning sensation is felt by him at the right of the median line. HCl free 1.09 per cent. total acidity 2.55 per cent. As the alkaline treatment and stomach washing and diet do not give relief he is sent to the surgical ward with diagnosis of gastric and probable duodenal ulcer with hyperacidity.

Röntgen examination: Stomach large, reaching a line two fingers under the iliac spines, hypertonicity, pylorus spasm, which does not allow the passage of the meal for one quarter of an hour. The emptying is quick—duodenal cap painful. Operation July 1, 1924, special anæsthesia with stovain normal. No organic lesion demonstrable.

Pylorus ring hard, thicker, especially towards the upper border, sphincterotomy according to Rammstedt, small opening in the duodenal wall stitched with very fine catgut as said above, implantation of a fold of omentum from the hepato-duodenal ligament: Leaves the hospital July 20, 1924.

Röntgen examination: Slight deformation of the pylorus, prompt evacuation of the stomach.

Examination on the first days of November: All the symptoms have disappeared after one month during which he felt some heaviness; general condition very good, attending with pleasure to his work.

Röntgen examination: Tony and peristalsis normal, emptying normal, the image of the antrum clear, round regular, pylorus normal, duodenal cap of spear form, normal.

Case II.—P. A., thirty years, male, enters the first pavillon June 24, 1924, present disease began April 23 with epigastric pain one-quarter of an hour after meals and lasting two hours, he was in the hospital under my care for a few weeks in June, 1923 and the diagnosis was left uncertain. After a good period, he had one night a sudden epigastric pain radiating to the spine, with vomiting of liquid with some red blood. Since that time pain one-quarter to one-half hour after meals, lasting three to four hours, acid eructation, seldom vomiting. After another period of hospital treatment he went out in the same condition, and comes again because of feeling worse. He has pain even in the morning and heaviness and pain increased after meals. HCl. free 0.6 per cent. total acidity 1.17 per cent.

Radioscopy: Stomach large and ptosic, two fingers above the pubis, peristalsis not strong, emptying normal, no pain on the duodenal cap.

Diagnosis: Ptosis and hypersecretion, probable ulcer duodenal.

July 5, 1924: Operation lumbar anæsthesia, stovain, normal. No organic lesion demonstrable, pylorus ring thick, hard, contracted especially toward the upper border. Sphincterotomy of two and one-half centimetre extension, the section of the sphincter seems thicker than normal, it is carefully freed from the submucosa and allowed to retract. A small free omental flap is sewn between the cut edges. Leaves the hospital on July 21, 1924.

Radiological examination of the 20th, evacuation normal, no deformation of the pylorus.

Clinical examination November 1, 1924. Symptoms have disappeared completely. Can eat the regular food. General condition flourishing.

Radiological: Pylorus normal, emptying of the stomach easy and prompt, duodenal cap normal.

Case III.—M. E., thirty-five years, male, enters the first pavillon July 21, 1924. Present disease began in 1913, in the summer months for two years pain two to three hours after meals, slight acidity.

From 1915 to 1917 well and served in the army, end of 1917 pain for four to five days and blood in the stools.

In 1919 epigastric pain four hours after meals lasting two to three hours spontaneously or immediately after small quantity of food. In October melena and coffee vomiting. Since then until February 22 periods of pain and good intervals. February 20, 1922, abdominal pain, abundant melena, 29th of June, 1924 renewed melena. He is sent by the medical ward with diagnosis of duodenal ulcer. No hyperacidity, stomach reaches a line two fingers under the iliac spines, is rather large, hypertonic, pyloric spasm lasting twenty minutes, after which normal emptying. Pain at the pressure on the duodenal cap, promoting vivacious peristalsis.

Operation July, 1924 (Author): No demonstrable organic lesion. Pyloric ring very hard especially towards the upper border, sphincterotomy according to Rammstedt as in Case I. Leaves the hospital on the 11th of August.

Radiological examination: Pylorus normal, the emptying is prompt and rapid.

Clinical examination on the 2nd of November, 1924: Has always been well, sometimes slight acidity. He still looks pale. Can attend to hard work. Can eat any kind of food without any trouble.

Radiological: Slight ptosis. Pylorus displaced backward, its form and function are normal. The emptying is rapid and complete.

CASE IV.—L. M., fifty-two years, male, since five years acidity and epigastric pain, sometimes radiating to the spine, a short time after meals, with heaviness of short duration, all together he has had up and downs but never fine intervals. He has tried many treatments and also a rest cure, without any result, and has lost weight. He shows a neurotic constitution and has many vague troubles of difficult interpretation.

The radiological examination showed a lobed conformation of the duodenum cap, the emptying normal, contractions strong, and a suspicion of a niche. For that reason he was submitted for an exploratory operation, November 5, 1924. No organic lesion was found, the pylorus was hard, and the duodenum between first and second portion was covered by a membrane fixing it, after cutting this, the duodenum was mobilized and thoroughly examined, with negative result. The sphincter was treated as in Case I.

The symptoms so far have disappeared.

The Röntgen examination shows the pylorus normal and the emptying very rapid after twelve days.

ANTETHORACIC ŒSOPHAGOPLASTY

A NEW METHOD

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During the last twenty years the problem of making a new œsophagus by plastic operation has engaged the attention of surgeons very much, especially for the relief of patients suffering from a benign stricture of œsophagus, as

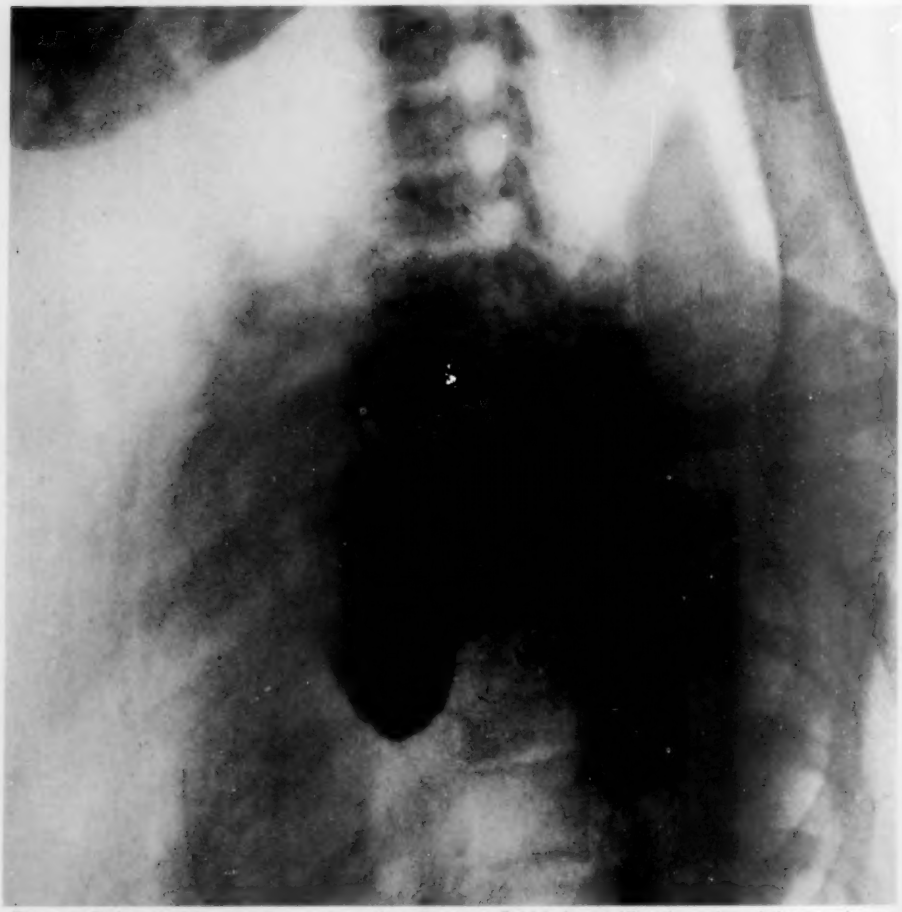

Fig. 1.—Stricture of the œsophagus; retention of opaque fluid in lower dilated portion of the œsophagus.

a rule caused by swallowing caustics (caustic acid or soda, etc.). The greater number of such cases seem—to begin with—capable of being cured or kept open by the introduction of bougies, but as a rule the patients return very soon with a bad recurrence, the stricture having become very difficult to pass with bougies. At last it becomes in many cases quite impossible, the patients emaci-

ate and, a catastrophe being imminent, we are forced to make a gastrostomy to keep the patient alive. Such a gastrostomy is really a wonderful help at first, but for a hard working person the nourishment in this way may possibly be insufficient, apart from the wear and tear of such a way of life.

In 1907 Roux, at Lausanne, in Switzerland, carried out the idea of an "antethoracic œsophago-jejunostomy" which had been theoretically proposed by Wullstein three years before (1904). This very complicated operation involved excision of a 40–50 cm. long loop of jejunum, the caudal lumen of which is implanted in the stomach, the oral is drawn through a subcutaneous channel in front of the sternum up to the neck, where it in a second stage may be united with the upper healthy part of the œsophagus.

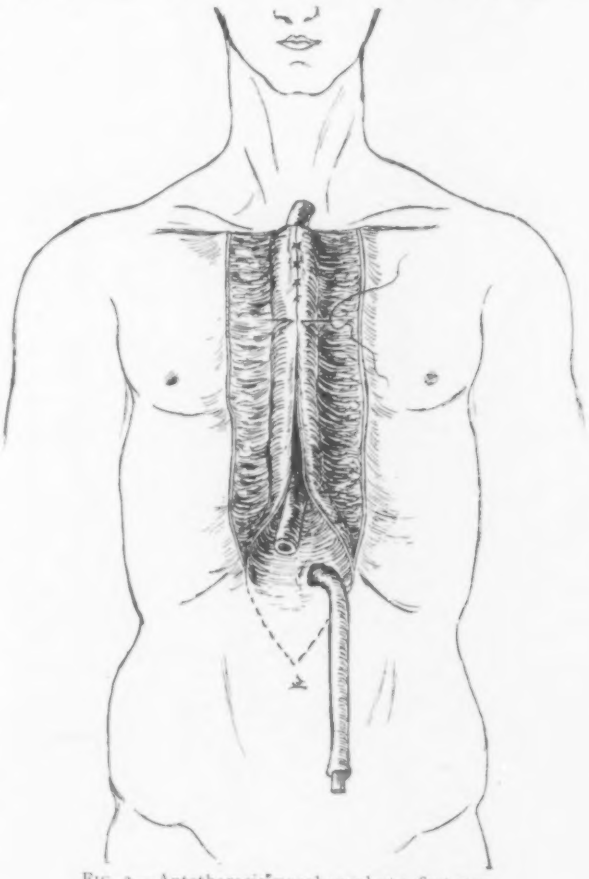

FIG. 2.—Antethoracic œsophagoplasty, first step.

This operation is very dangerous for various reasons: 1. There is a great risk of peritonitis, because one has to carry through a very complicated intraperitoneal operation in a patient who has borne a gastrostomy for a long time past. The skin round the gastrostomy is often ulcerated, irritated, and difficult to clean; the presence of the gastrostomy gives a narrow and difficult space for the laparotomy, under which the content of the stomach may easily enter the cavity and soil the wound. 2. The nutrition of the transplanted loop of jejunum is very poor and always in a great risk to be interrupted by torsion of the little pedicle of mesentery and by the compression between the skin and sternum. Therefore total or partial gangrene of the new œsophagus happens very often. Hence the many efforts to simplify the method:

Kelling, Vulliet and v. Hacker making use of the transverse colon which should be more mobile and better nourished than the jejunum. I think that

the greater risk of septic infection from the content of colon neutralizes the mentioned advantages.

More reasonable seems to me the modifications in which the *stomach* itself is used as a transplant.

v. Fink tried (1913), having cut the duodenum through near the pylorus and closed the caudal part, to draw the central stump of the duodenum and the stomach up under the skin to meet the cervical part of the œsophagus. A gastro-enterostomy before closing the laparotomy wound was of course a necessary supplement.

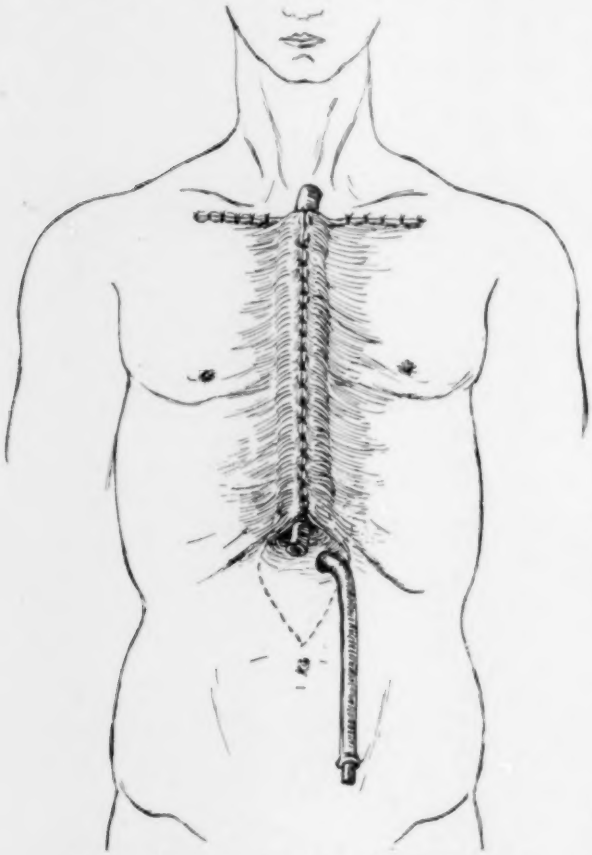

FIG. 3.—Antethoracic œsophagoplasty, second step.

Kirschner made—fearing the anti-peristalsis—the opposite use of the stomach, cutting this by cardia and drawing the cardial part up between the sternum and skin to meet œsophagus. Here it was necessary to make an anastomosis between the jejunum and the cardia.

Less dangerous is the method of Jianu, who makes a new œsophagus from the great curvature of the stomach: by two parallel incisions a long flap is dissected free from near the pylorus up to the fundus of the stomach, the stomach wound is then closed by sutures up to the basis of the flap, where a new cardia is built by uniting the borders of the flap to a channel, which then is drawn up as an antethoracic gullet.

This method has three sides open to criticism: 1. The long suture line. 2. production of hydrochloric acid and pepsine by the mucous membrane, whose corrosive effect may compromise the healing. 3. If there really is some peristalsis, this may work in the wrong direction as antiperistalsis. It should be remarked that all these dangers and difficulties of the different methods are due to the conviction, that the new builded gullet must be capable of peristaltic motion.

Is that true? This is the question I have put before myself thinking,

that if not true, we could build the new gullet without all the mentioned risk by simple skin plastic.

The answer was not difficult, many facts showing me, that peristalsis is not at all necessary.

We know from observations of the majority of the successful cases that the peristalsis, if it has been present at all, very rapidly disappears whether it was jejunum, colon or stomach. This seems to me not surprising, because the transplant may blend very intimately with the tissue in which it is embedded.

Moreover we know, from Gluck's and Torek's cases, that a simple rubber drain uniting an œsophagostomy with the gastrostomy through many years can function in a rather satisfying manner. Torek's famous patient, an elderly woman, whose cancer he extirpated with a successful resectio œsophagi, is still living ten years after.

These considerations encouraged me to work out a more simple and less dangerous method, which I have performed with success in two patients, both of whom now are quite cured and are very happy. Three other patients are still under treatment.

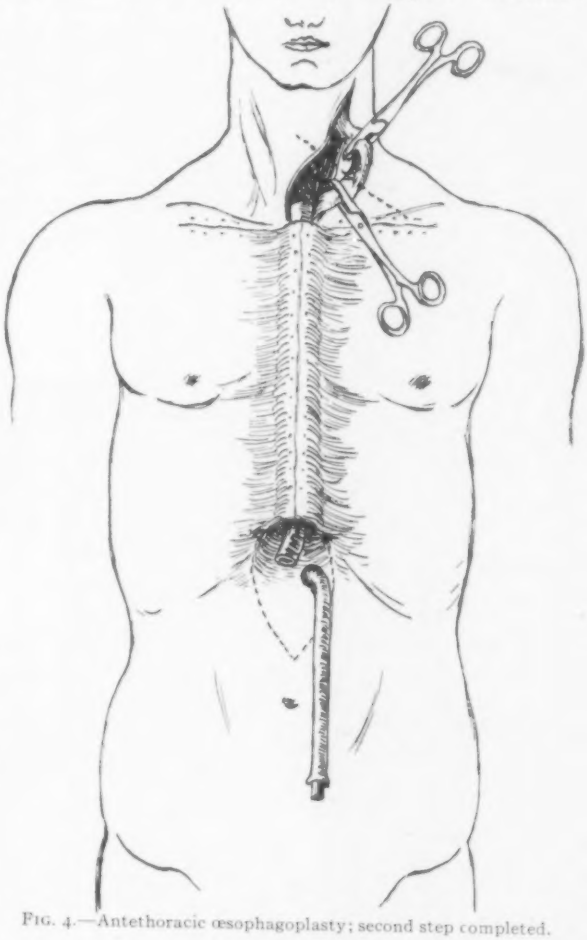

FIG. 4.—Antethoracic œsophagoplasty; second step completed.

My third and fourth patients are children, two boys, respectively five and nine years old, the fifth is a young girl, twenty-one years old, with an impermeable stricture, developed after a diphtheria.

CASE I.*—K. J., thirty-four years of age. Entered my private clinic February 4, 1921, dismissed June 8, 1921. Four and a half years before she swallowed a big gulp of caustic soda, after which there rapidly developed a quite impermeable stricture of the œsophagus, so that already three months after she could not possibly swallow fluids. At the *Aalborg Hospital*, Doctor Eschen performed a gastrostomy, through

* Published in Hospitalstidende No. 1, January, 1923.

which she has been nourished ever since. She has in the last years steadily lost in weight—totally 25 kilograms—her weight is now only 45 kilograms.

Status præsens: Emaciated, anæmic, miserable looking. If she tries to swallow a little fluid, she vomits at once.

The Röntgen photo shows a complete impermeability of œsophagus 8 cm. below the jugulum (Fig. 1).

February 17, 1921. Œsophagoplasty first step (Figs. 2 and 3). From two parallel incisions, beginning above the jugulum, terminating underneath the gastrostomy, where they meet, the skin is dissected free inwardly so far, that it can be united round a big rubber-tube, and outwardly so far that the skin from the sides can be dragged together and united in the midline. On the 31st of March I accomplished the second stage (Figs. 3 and 4). Through an oblique incision along the anterior border of the sternocleidomastoideus I dissected the œsophagus free insofar, that I could bring a finger round it and lift it up to the incision of the skin. Between two clamps I cut the œsophagus through, the inferior end was then dragged out through a small incision in the left supraclavicular fossa, fixed here to the skin by silk sutures and drained by a tight rubber-drain. The oral end of the œsophagus was united with the new-formed antethoracic skin tube.

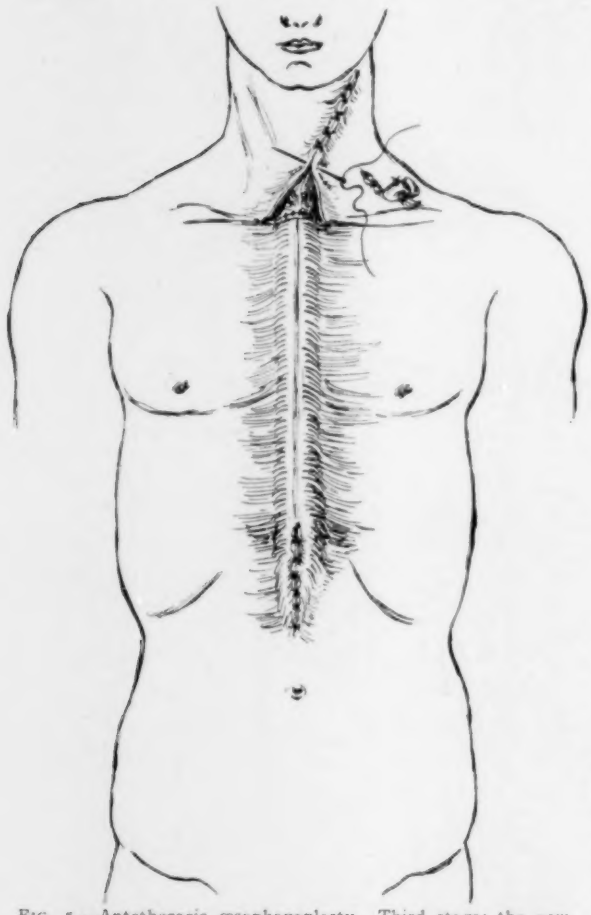

FIG. 5.—Antethoracic œsophagoplasty. Third stage; the new œsophagus now continuous with the stomach fistula.

Third stage, April 29, 1921: After removal of the Pezzer drain from the gastrostomy, the skin round this was united in continuity with the antethoracic skin-gullet, as shown in Fig. 5.

At two subsequent times, July 6 and 21, I had to close a little fistula at the upper end of the skin-gullet. The final result is shown by Fig. 6.

Since then the gullet has functioned quite well. She gained 30 Danish pounds (=15 kilos) in the first six months. She is able to eat and swallow every kind of food, is able to care for her house and five children without help. She has sometimes cardialgia, which usually disappears in a few days by means of bicarbonate of soda. She is now, three and a half years after the operation, quite happy.

CASE II.—Jenny Dorothea P., aged eighteen years, swallowed in January, 1920, by mistake a mouthful of caustic soda. In the following weeks a quite impermeable

stricture developed in the thoracic part of the œsophagus. October 19, 1920, I performed gastrostomy with good immediate effect upon the very miserable, emaciated girl, but in September, 1921, she returned to the hospital in a very bad condition: anæmic, emaciated and suffering much pain. I judged it then absolutely necessary to perform an antethoracic œsophagoplasty, if her life was to be saved. The operation was done exactly in the same manner as in the first case: First stage, October 25, 1921; second, February 7, 1922. Third, March 10, 1923. In this case we met some trouble and delay of the

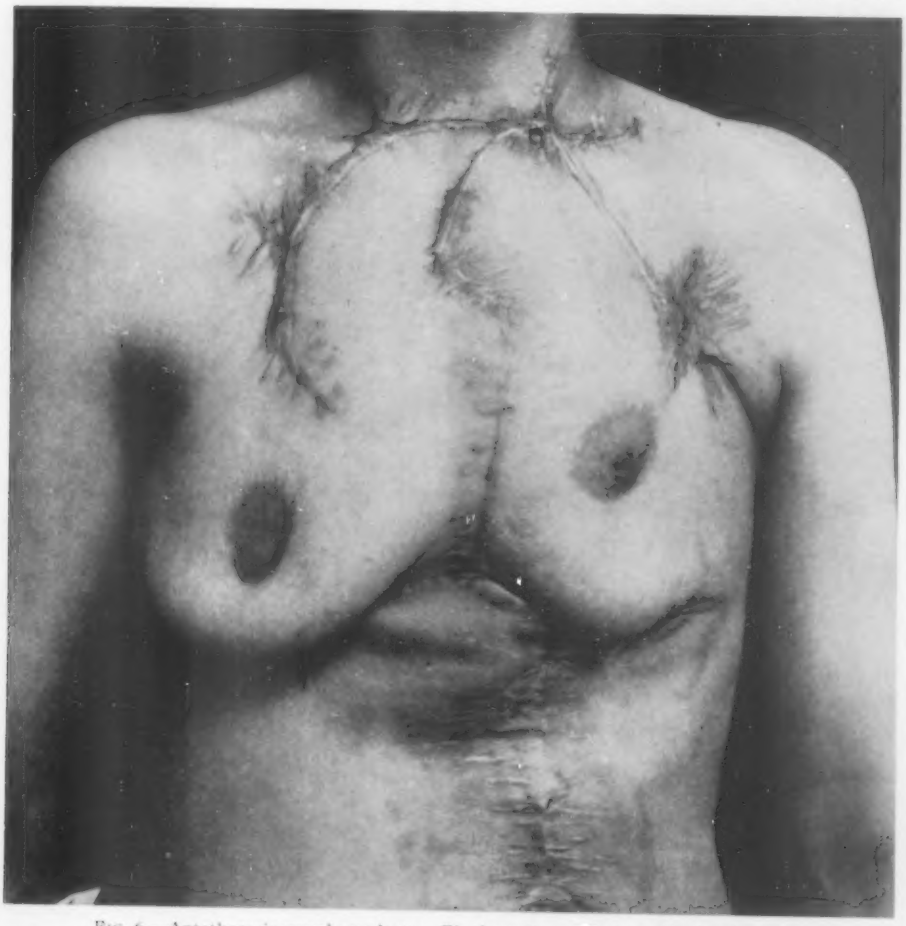

FIG. 6.—Antethoracic œsophagoplasty. Final result; excellent swallowing function.

healing, caused by reiterated eruption of a syphilitic infection, contracted in 1919. But since April, 1923, this patient has been quite cured, able to take normal food and able to work.

In addition to these two quite cured cases, I have three other still unfinished cases in treatment.

CASE III.—A boy, five years old, with an impermeable stricture in the thoracic œsophagus after swallowing caustic soda. The two first stages of the œsophagoplasty are made, and we are now going to finish the skin-plasty round the gastrostomy.

CASE IV.—A boy, nine years old, with a quite impermeable stricture after swallowing caustic soda. Here I have made the gastrostomy and the œsophagostomy, and I am about to unite the two openings by an antethoracic skin-tube.

CASE V.—E. J., a woman, twenty-one years old, with an impermeable stricture,

beginning above the jugulum, continuing downwards to the diaphragm, which developed after a very serious diphtheria. Here I have made gastrostomy, and as second step the œsophagostomy cervicalis and hope in a few months to be able to unite the two ostia through an antethoracic skin-tube.

I have in my last two cases altered my method insofar as I make a quite simple œsophagostomy, suturing the upper lumen of the divided œsophagus to the skin of the neck, before making the antethoracic tube by skin-plasty, surrounding the œsophagostomy by the skin-flaps in the same way as I surrounded the gastrostomy in my first cases. I avoid in this way the great difficulties which attend uniting directly the lumen of the œsophagus cervicalis to the double antethoracic skin-tube. It is very difficult—if possible—to get a primary complete healing at this point, and by this defective healing we may get fistulas with building of granulations, which may make a hindrance for the passage of food, perhaps leads to veritable stricture.

I think that this modification may be a further improvement, make the operation easier and more effective, and save much time.

I hope that these experiences have demonstrated that the method marks a very important progress in the operative treatment of these very difficult and very serious diseases. The method reduces the risk to a minimum, while it gives as good functional results as the old, very dangerous methods.

The only dangerous moment of the operation is when we are cutting the œsophagus cervicalis through, but I find it quite necessary. A side-opening in the œsophagus is absolutely insufficient for the passage out into the skin-tube. It permits the food to enter the cul-de-sac above the stricture, with subsequent stagnation, decomposition and inflammation. It is much better, as it is done by my method, to clean the cul-de-sac by draining it.

By cutting the œsophagus I introduce and fix tight by suture, a rubber drain in each lumen before cutting the posterior wall of the œsophagus. In this way I prevent oozing of infected matter into the mediastinum.

SO-CALLED IDIOPATHIC DILATATION OF THE ŒSOPHAGUS

SYNONYMS: DILATATIO FUSIFORMIS ŒSOPHAGI, CARDIOSPASMUS, MEGAŒSOPHAGUS

FIVE CASES, OF WHICH FOUR HAVE BEEN TREATED BY MEANS OF ŒSOPHAGO-GASTROSTOMIA SUBDIAPHRAGMATICA

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By idiopathic dilatation of the œsophagus is understood a diffuse enlargement of the lumen of the œsophagus, with the following characteristic features:

1. The dilatation is considerable, being as a rule far greater than in any other affection of the œsophagus, and as a rule is most pronounced in the lower two-thirds of the tube, the dilatation is often combined with an elongation of the œsophagus.

2. The cause of this diffuse dilatation is unknown, hence the name idiopathic; in particular it is not due to any organic stricture.

3. This disease is never cured spontaneously or by medical treatment only.

Regarding the first and third points there prevails some degree of unanimity, and regarding the second great disagreement, many people consider that the cause is far from being unknown, although there by no means exists unanimity as to what are the etiological factors. The various views thereof, in connection with the desire to have this expressed also in the nomenclature of the disease, have led to the result, that in addition to idiopathic dilatation of the œsophagus there are also a number of other names for this complaint. The most common is *Cardiospasmus* (Mikulicz, 1882), by which it is desired to express the fact that dilatation of the œsophagus is dependent upon a spasm at the cardia. As we shall see later on, however, there exists disagreement as to whether the supposed spasm is situated in cardia, in the abdominal part of the œsophagus or in the diaphragm, where the œsophagus passes through the latter. Supporters of the last-named view therefore speak of *phrenospasm* (Chevalier Jackson) instead of cardiospasm. Hertz (1914) employs the term *achalasia cardiæ, i.e.*, lack of relaxation. *Megaœsophagus* (Bard, 1918) is an apparently neutral expression, by which it is merely intended to designate a large œsophagus, but as in other "megas," *e.g.*, megacolon, there is also concealed in the term megaœsophagus a slight reservation that the disease is congenital.

The most neutral designations are those which only pay regard to the form of the œsophagus, *e.g.*, *dilatatio ingluviformis* (ingluvies = crop) *œsophagi* (Huss, 1842), *dilatatio fusiformis* (Luschka, 1868) or *dolicho-œsophagus*, in which, it is true, only the increase in length and not the widening of the œsophagus appears in the term.

Are these various diagnoses also expressions of really different complaints, or is it desired thereby merely to put forward that the same clinical picture can be produced by various pathological anatomical changes? It is this that we shall further investigate in the following pages, although I must at once make clear that dilatations resulting from undoubted stenoses in (corrosions, cancer) or outside the œsophagus (mediastinal tumors, aortal aneurisms) are not included in the present work.

Pathological Anatomy.—Our knowledge of the pathological anatomical changes observed in the œsophagus is based partly upon clinical observations, partly upon observations at operations or at post-mortem examinations.

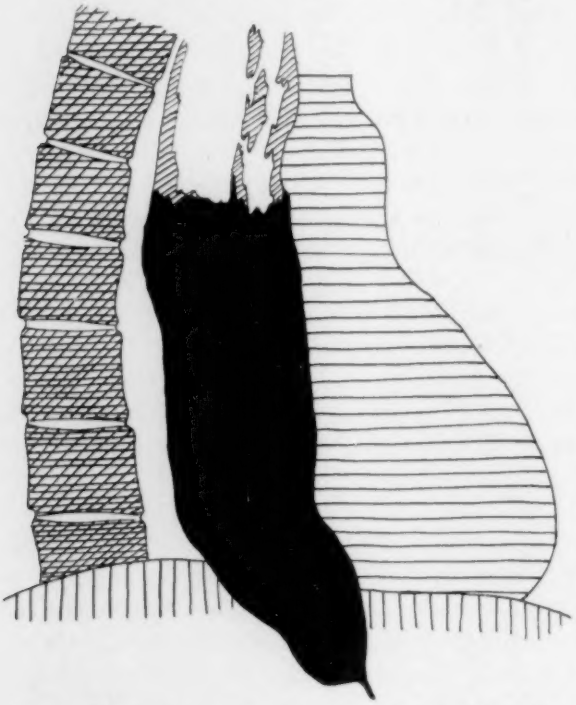

FIG. 1.—Idiopathic dilatation of the œsophagus—Case I. Before the œsophago-gastrostomy.

As mentioned above, dilatation most often affects the lower two-thirds of the thoracic œsophagus; even in those cases where even the cervical part is dilated, the dilatation is always most pronounced in the lower two-thirds of the thoracic part. The abdominal part of œsophagus as a rule is not dilated, even though there are a number of instances where it has also taken part in the dilatation. (Ehret, Key, Sargnon and Arcelin.)

The dilated œsophagus may be spindle-shaped, sausage-shaped or more often broader below, *i.e.*, bottle-shaped or pear-shaped. Once (Wibrecht) the dilatation was hour-glass-shaped.

In addition, we very often find an elongation of the œsophagus, up to 46 cms. (Luschka); we then see that the œsophagus assumes a more or less pronounced S-shape, with the lower half bent markedly over to the right, so that a large curve rests upon the right half of the diaphragm (Cp. Figs. 3, 4, 9 and 12).

The volume of the dilated œsophagus varies from 1400 to 2000 cc.[3] (Ehret, Guisez, P. Hirsch); it is very commonly 1 litre or thereabouts. The greatest breadth of the opened œsophagus varies from 6–7 to 16 cms. (Harbitz, Gottstein), or 21 cms. (Giesse); the greatest circumference was shown in Luschka's case, 30 cms., *i.e.*, like the arm of a powerful man.

The wall of the œsophagus is almost always thickened, as much as 5–6–7

mms.; the thickening mostly affects the circular layer of muscles, 3–4 mms., whilst the longitudinal layer may be of normal thickness, 1 mm., or even thinner.

The appearance of the mucous membrane may be quite normal, but we often find more or less distinct signs of inflammation, from fraying of the epithelium to leucoplac-like thickening of the latter, or all degrees of ulcerous inflammation with infiltration of all the layers of the wall, sometimes in the form of a phlegmon with secondary periœsophagitis. The inflammatory changes are most pronounced in the lowest part of the dilated œsophagus, at least in the initial stages.

The microscopic picture varies greatly, according as there is inflammation or not. In some cases the cells of the muscles are normal, in others they show signs of degenerative changes in the form of brown granulæ (Fr. Gregersen).

The greatest interest is connected with eventual alterations in the cardia or the lowest part of the œsophagus. In order to ascertain these conditions, I have examined the reports of 42 cases of operations and 62 of post-mortem examinations. On the other hand, I have disregarded observations made as to the condition of the cardia in probing or œsophagoscopy, as these can scarcely be regarded as reliable as those mentioned above.

In 42 cases of operation the cardia was found normal fourteen times, and altered twenty-eight times. In 68 post-mortem examinations there were 38 normal cardiæ and 24 altered cardiæ. Thus in 104 cases—operated or examined post-mortem—the cardia shows normal conditions in 52, and alterations also in 52 cases. By cardia we must here understand not only that which is so designated anatomically, but also adjacent parts of the œsophagus.

I consider it superfluous to quote those cases in which the cardia was found to be normal. On the other hand, I will give below a survey of the alterations in the cardia and the lowest part of the œsophagus that have been demonstrated at operations and post-mortem examinations.

I. OPERATIONS FOR DILATATIONS OF THE ŒSOPHAGUS WITH DEMONSTRATED ALTERATIONS IN THE CARDIA

1. *Bard*, 1918: Man, twenty-three years of age. Cardioplasty (Girard, 1916). Cardia thickened and adherent to spleen and liver.

2. *Hj. v. Bonsdorff*, 1906: Man, twenty-four years of age. Digital divulsion of cardia after opening the stomach. *First finger inserted into cardia with difficulty.*

3. *O. Borchgrevink*, 1916: Man, forty-five years of age. Cardioplasty á la Röpke. *At the lower part of the abdominal œsophagus a long fibrous thickening, 2 cms., not* passable for probe No. 15.[1]

4. *O. Borchgrevink*, 1921: Boy, fifteen years of age. Heller's cardioplasty. *Impassible constriction of cardia.*

5. *F. Brüning*, 1906: Man, twenty years of age. Mikulicz's operation. *Cardia felt like a fixed ring. A finger could not pass.*

6. *Clairmont*, 1921: Man, sixty-two years of age. Extramucous cardioplasty. *Pars abdominalis œsophagi contracted.*

[1] *Francis Harbitz* describes the results of dissection of this patient 4 days later in the following manner: "Cardia only just admits one finger. No scar, sore or other sign of organic stenosis at any place; no sign of chronic inflammation."

7. *Dauber*, 1900: Man, thirty-eight years of age. Gastrostomy. *Cardia thickened, hypertrophic;* thick stomach probe, however, could be inserted.

8. *Exner*, 1917: Man, thirty-six years of age. Œsophago-gastrostomia subdiaphragmatica. *Cardia as thick as lead-pencil.* Wall for a length of 3 cms. *transformed into a hard cicatricial tissue as after an ulceration.*

9. *Finisterer*, 1922: Man, twenty years of age. Œsophago-gastrostomia subdiaphragmatica. Fundus ventriculi adherent to spleen and liver, *cardia squeezed between cicatricial cords and columnæ.*

10. *Finisterer*, 1922: Woman, forty-two years of age. Œsophago-gastrostomia subdiaphragmatica. Marked adhesions (gastrostomy had been performed previously). *Cardia transformed into a stiff ring;* dilatation commences 2 cms. above cardia.

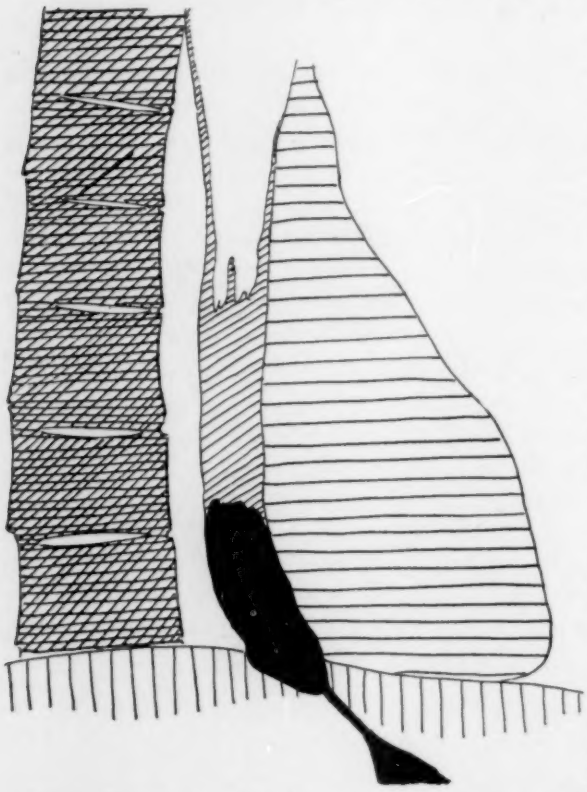

FIG. 2.—Case I. About three weeks after the œsophago-gastrostomy. Taken fifteen minutes after the patient had drunk barium water.

11. *Graff*, 1907: Man, forty years of age. Mikulicz's operation. *The mucous membrane of cardia strikingly thickened and folded.*

12. *Heller, E.*, 1913: Man, forty-nine years of age. Extramucous cardioplasty. *The 3 lower cms. of œsophagus spasmodically contracted, the thickness of a little finger,* with a sharp limit up towards the dilated part.

13. *Hertz and Braine*, 1924: Boy, thirteen and one-half years of age. Extramucous œsophagoplastic ad viam thoraco-abdominalem. That portion of the œsophagus which goes through hiatus is very long and narrow, with a distinct contraction, 3 cms. long and scarcely 1 cm. broad.

14. *Heyrovsky*, 1911: Woman, thirty-four years of age. Œsophago-gastrostomia subdiaphragmatica. *Great cicatrical stenosis of cardia, which has the* thickness of a lead pencil.

15. *Lardennois and Braine*, 1923: Man, ? of age. Débridement of the left diaphragmatic crus. *No obstacle in cardia: the obstacle appears to be situated higher up.*

16 *Lecéne*, 1919: Man, twenty-three years of age. Cardioplasty. *Fibrous bridge across end of œsophagus squeezes it together. Œsophagus here distinctly thickened, the wall fibrous.*[3]

17. *Lindström*, 1918: Woman, forty-three years of age. Gastrostomy. Subsequently digital divulsion without opening the stomach plus extramucous cardioplasty. *Somewhat thick circular tumor of muscular tissue corresponding to the narrowest part.*

[3] Lecéne writes in 1924 regarding the same patient: "Correctly speaking, no organic stricture of the wall of the œsophagus, no palpable sclerosis or thickening of the wall."

18–21. *Mikulicz*, 1904: Mikulicz's operation. *In four cases only the tip of a finger could be inserted through cardia.*

22. *Kramer-Peterson*, 1908: Woman, twenty years of age, Digital divulsion of the cardia per gastrotomiam. *Cardia contracted.*

23. *Pamperl*, 1919: Woman, twenty-four years of age. Digital divulsio cardiæ per gastrotomiam. *Œsophagus greatly constricted in hiatus*, circular stenosis of the cardial part of the œsophagus produced by a hard ring several mms. in breadth, that does not belong to the diaphragm, but to the muscularis.

24. *Pamperl*, 1919: Woman, twenty-two years of age. Operation as in previous case. *Cardia easily passed, but great resistance by a circular ring some mms. from diaphragm;* after three fingers had passed the latter, another ring was felt higher up, firm and tendinous, but not so narrow.

25. *Rovsing*, 1913: Woman, forty-two years of age. Gastrostomy, hepatopexy, gastropexy. Gastrocoloptosis. *Œsophagus bent to the right at the edge of cardia.*

26. *Schaldemose*, 1916: Man, forty-six years of age. Circular section of the muscular coat 1 cm. above cardia. *Cardia like a small contracted eyelet.*

27. *Wendel*, 1910: Woman, forty-six years of age. Cardioplasty (á la Heinecke-Mikulicz). *Cardia and 4 cms. of œsophagus as narrow as a thick lead pencil;* a transverse, somewhat large artery. It resembles a spastic, intestinal contraction.

28. *Wendel*, 1921: Extramucous cardioplasty. *Firm ring of connective tissue at cardia.*

II. POST-MORTEM EXAMINATIONS OF DILATATIONS OF ŒSOPHAGUS WITH ALTERATIONS IN THE CARDIA

1. *Bensaude and Guénaux*, 1921: Man, twenty-one years of age. Died after self probing. *4 x 2½ cms. large wound on anterior wall of œsophagus just above cardia.*

2. *Chappet*, 1878 (after *Baudin*): Woman, sixty-three years of age. *Slight retraction of cardial opening.*

3. *Falkenheim*, 1921: Woman, seventy-one years of age. *Cardia thickened, narrow, diameter 22 mms. for an extent of 2 cms. after being opened.*

4. *Giesse*, 1860 (after *Berg*): Woman, sixty-seven years of age. *Cardia completely normal, perhaps a little narrow, 35 mms. in diameter when cut open.*

5. *Tetens Hald*, 1911: Woman, twenty-nine years of age. No constriction of cardia, but cul de sac at the side of it.

6. *Herbitz*, 1917: Man, twenty-seven years old. *Cardia 2.5 cms. cut open.* Only slightly pronounced changes microscopically.

7. *Heissler*, 1909: Man, thirty-six years of age. *The lowest 2 cms. of œsophagus are narrow and slack, mucous membrane thickened distinct and sharp bend on right side between the dilated and the narrow parts.*

8. *Hirsch*, 1919: *Cardia narrow, 3 cms. in diameter when cut open; the same applies to pars abdominalis œsophagi.*

9. *Huss*, 1842: Woman, forty-two years of age. *No organic stricture of cardia, the opening a little narrow, but fully yielding.*

10. *Kelling*, 1903: Woman, sixty-nine years of age. *Cardia measures 12 cms. in circumference.*

11. *Kelling*, 1903: Woman, forty-seven years of age. Perforated by probing. *Old callous cicatrice posteriorly to the left occupying one-third of the œsophagus.*

12. *Leichtenstern*, 1891: Girl, nineteen years of age. *Cardia greatly contracted, measures 3.6 cms. when cut open.*

13. *Lindau*, 1840: Man, thirty-four years of age. *Cardia transformed into a thick, hard ring.*

14. *Monakow*, 1892: Woman, thirty-two years of age. *Œsophagus turned round on its longitudinal axis with a kink in the anterior wall. Cardia retracted, but a probe passes easily.*

15. *Purton*, 1831: Man, thirty-two years of age. *Cardia permeable, but contracted.*

16. *Reinhardt*, 1920: Man, forty-two years of age. *Cardia just admits one finger.*

17. *Rokitansky*, 1841: Man, twenty-four years of age. *Cardia narrow, extending into the stomach like a portio uteri.*

18. *Rumpel*, 1899: Man, fifty years of age. 2 cms. above ora serrata, normal breadth of œsophagus, but it is *firmly contracted.* Normal conditions microscopically. Died after self probing.

19. *Rumpel*, 1899: Woman, forty-two years of age. The lower 4 cms. of œsophagus of normal width. *Cardia contracted*, and offers a certain degree of resistance to finger.

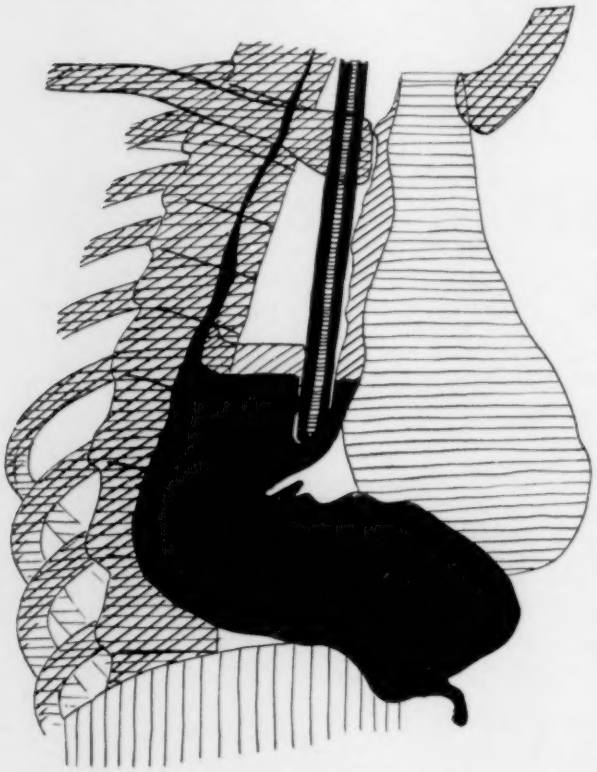

FIG. 3.—Case II. Before the œsophago-gastrostomy. Shows the bougie stopping against the anterior wall of the œsophagus.

20. *Batty Shaw and Woo*, 1916: Man, fifty-five years old. 4 cms. below the fusiform dilatation there is a slight cylindrical extension with *pronounced hypertrophy. The wall is 7 mms thick.* The lower 1–5 cms. of the œsophagus are normal; no scar or ulceration.

21. *Batty Shaw and Woo*, 1916: Woman, fifty-one years old. Introitus and *cardia of normal size.* At lower end of the œsophagus an oval ulceration, just above cardia, one inch in length, thickened in parts with rim turning outward (Not examined microscopically); dysphagy for four years.

22. *Schmidt* (after *Baudin*), 1899: Man, forty-one years of age. *Cardia normal, 2.8 cms.*

23. *Stierlin*, 1911: Woman, eighty-four years of age. *Diameter of cardia abnormally small, 2.8 cms. when cut open; mucous membrane normal*, no signs of cicatrice or adhesions.

24. *Wiebrecht*, 1897: Man, eighteen years of age. *Cardia normal, 2.8 cms.*

This general survey could be considerably enlarged without difficulty, but I scarcely believe that the final result would be appreciably changed. As will be seen, a normal cardia was found in 52 cases, 50 per cent., in another 50 per cent. alterations of the same or of the lower part of the œsophagus. These alterations have in common a more or less pronounced stenosis, the seat and nature of which, however, vary considerably. We are not confronted by any pathological-anatomical unity.

In a number of cases it is merely stated that the cardia was a little constricted, in others that it was normal, whilst the dimensions given, however, show that the diameter of cardia was below the average (Schmitt, Wibrecht);

in these cases, it is true, there are no macroscopic signs of chronic inflammation. In some cases it is stated that the cardia or the lower part of œsophagus was contracted and hard, but by degrees yielding, which some authors (*e.g.*, Leichtenstern) regard as a spasm that continues even after death. Regarding other cases, it is said that the cardia or the lower part of the œsophagus was fibrously thickened, or confined by adhesions, or cicatricial cords; in other words, has shown signs of chronic inflammation.

In other cases it is expressly noted that the cardia itself was normal, whilst higher up, in hiatus, constrictions of the lumen were demonstrated. (Hertz-Braine, Lardennois, Pamperl). Others again, designated the obstacle as a "cul-de-sac" (Tetens Hald) or kink (Heissler) above a normal cardia. Sometimes it is shown that there is a solitary ulcer of considerable size in the lowest part of the œsophagus (Batty Shaw and Woo, Bensaude and Guénoux). *Atrophy of nervi vagi* was demonstrated by Kraus and Ridder in one case.

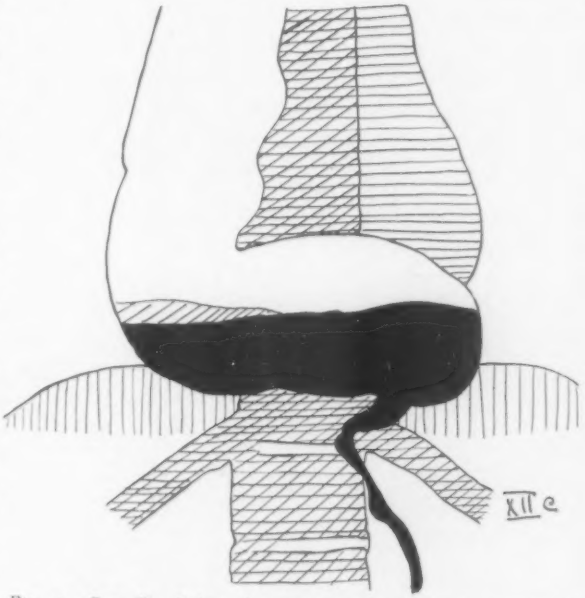

FIG. 4.—Case II. Before the œsophago-gastrostomy. Residue in œsophagus twenty-four hours after opaque meal.

Cancer œsophagi is a complication that has been observed many times. (Albu, Fleiner, Ewald, Reinhardt, Guisez.)

Œsophageal diverticulum has been observed in company with idiopathic dilatation of the œsophagus (Leffler).

Symptoms.—Until nearly the end of the last century this disease was only found during post-mortem examinations. In the course of the years 1880–1890 the clinical picture was studied, and the disease was also recognized in living persons. But it was especially after the introduction of Röntgen investigation and œsophagoscopy that it was perceived that the disease was no longer a *rara avis*. It is now regarded as, next to cancer, the most common of all diseases of the œsophagus. Thus Hugo Starck states that he has treated 40 cases, Frank Smithies 76 in seven years, and Guisez 48 in the last three years.

We have a number of scattered instances of a dilated œsophagus, in some cases greatly so, being found by chance at post-mortem examinations, without any demonstrable cause, and without there being forthcoming in the history of the case any information regarding previous clinical symptoms of

the same (Faure, Harbitz, Wilks). Faure's two patients both died suddenly, a circumstance which he directly connects with the dilatation of the œsophagus.

In general the disease begins clinically in one of the following ways:

A somewhat young or middle-aged individual one day suddenly notices during a meal (Cf. Cases II and V), or when drinking (Cf. Case I) that the food or the liquid does not go down into the stomach, but remains fixed in the œsophagus, this being accompanied by a feeling of pressure on the chest. After a few minutes the food or liquid, respectively, rise unchanged and the pain ceases. Such an attack takes place either without evident cause or in connection with an abundant meal, or especially when consuming cold or extra warm drinks or those containing CO_2. Most patients are at once aware that it is really a case of the substance swallowed not passing in the usual manner. In the immediately succeeding days the patient is usually careful when eating, until the unpleasant event by degrees fades more and more out of remembrance, accordingly as swallowing again takes place in the usual manner. After the lapse of weeks or months another attack occurs, and then others at shorter and shorter intervals. After a period that varies very greatly, the patient also has difficulty between the actual attacks in swallowing food, whilst on the other hand the attacks may entirely disappear—the disease is fully established.

But this development may also take place in a less dramatic manner. The patient little by little has the feeling that solid food (especially meat, bread or potatoes) does not pass as easily as before, whilst drink or semi-liquid food pass unhindered into the stomach. The patient himself often perceives that it is necessary to give himself better time during meals. He chews his food more carefully and either during the meal or after it takes considerable quantities of liquid. When the swallowing difficulty appears, there simultaneously occurs pain behind the sternum, in the epigastrium, or even in the throat, not always equally pronounced, and most noticeable after an ample meal. Sooner or later after the meal the patient feels that "something" in the œsophagus slips down into the stomach, after which he at once feels relieved. The condition may remain thus for years with only slightly pronounced symptoms and long, better periods in between, without the general condition of the patient being appreciably influenced. In other and rarer cases the difficulties increase rapidly, so that in the course of some months or a year, marked emaciation occurs. The latter, however, usually appears sooner or later in most patients who do not come under rational treatment in time.

Before this takes place, there has usually developed a highly characteristic clinical picture, the most essential features of which consist in the almost continual retention of remains of food in the œsophagus. As these patients are rarely plagued by nausea, they sit down to table with a good appetite, they eat a little slowly perhaps, chew more thoroughly, and drink more than others. Sometimes they take a gulp for each piece of food. Yet, at the beginning of the meal an outsider cannot always perceive that there is anything the matter with the act of swallowing itself. By degrees, however, there occurs

a feeling of pressure behind the sternum or of constriction in the throat; at the basis of the neck in rarer cases there is formed a visible swelling. The patient becomes uneasy, gets up from the table suddenly and his food rises. During this it also happens that remains of previous meals come up with that which has just been consumed. The patient then sits down to table again and begins afresh. This disgorgement may be repeated several times during the same meal, and this in connection with slow eating causes the patient "constantly to remain sitting after the others." Some patients soon discover that the pain in the chest is not only relieved by disgorgement, but also when they merely belch. This ructus may in some cases take place suddenly and noisily, quite like an explosion. If it is a child whose meals are constantly interrupted by disgorgement and belching, it is perhaps not so remarkable that its relatives scold it for lack of decent manners at table.

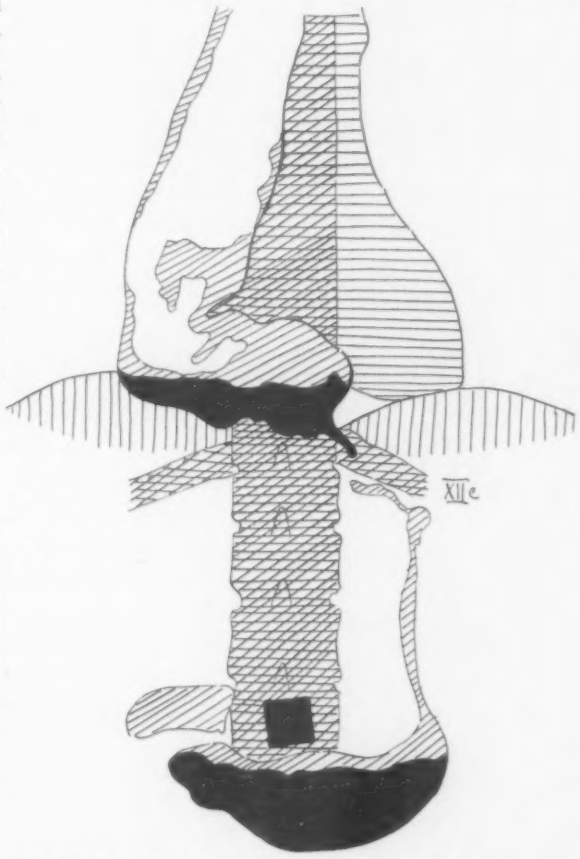

FIG. 5.—Case II. Four weeks after the œsophago-gastrostomy. One hour after opaque meal.

In the course of time many patients instinctively learn a number of various "tricks," whereby they are able to get the contents of the œsophagus into the stomach, so that to some extent they avoid disgorgement. The simplest way is to strain oneself, as if excremating. But most patients do more than that. During the meal or afterwards they quickly swallow one or often several glasses of fluid, water, milk, etc., then rise suddenly from the table, straighten their backs well, stretch their necks, take a deep breath, close the glottis, and then they make such violent expiration movements that some even become quite blue in the face and their eyes become bloodshot and full of tears. These manœuvres may be further supported by pressing one's hands against the thorax or by thumping with all one's might on the chest. Cordier (quoted from Gaudet) tells of a remarkable manœuvre in the case of a man, twenty-four years of age. From the age of

eighteen years he had periodically thrown his head far backwards in order to get his food down, and his friends employed the appropriate expression that he acted like chickens, " Il faisait la poule." After having kept up the above-mentioned more or less tiring manœuvre for a time, the patient often suddenly feels that as it were a flap opens low down in the chest, or that the string of a bag is suddenly released, and the greater part of the food in the œsophagus at once rushes down into the stomach. Simultaneously it is seen that the tortured expression of the patient during the manœuvres is replaced by a satisfied smile or grin.

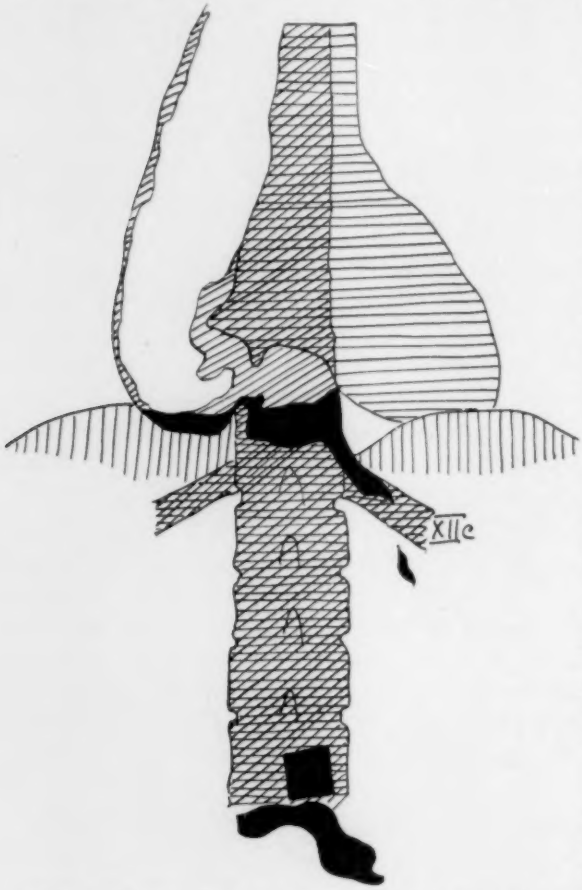

FIG. 6.—Case II. Same as Fig. 5, but taken ten hours after opaque meal.

One of my patients (Case IV) swallowed three or four glasses of water in the course of a meal, strained herself in the above-mentioned manner, and when she felt the food pass into the ventricle, she brought back almost all the water, the latter only slightly turbid. It really seemed as if she possessed a mysterious power of keeping the valuable part of the meal down in her stomach, whilst she could get rid of the water as soon as the latter had played its part as a mechanical factor.

These "tricks" do not always bring about a fortunate result. In spite of all efforts, the food will not go down, but comes up again. If that kind of patient succeeds in getting the food to pass, he feels relieved for several days afterwards (Cf. Case II). Some patients swallow a quantity of air instead of liquid (Cf. Case I) before they begin their manœuvres. Others constantly swallow air without knowing that they do so. They are pure " aërophages," and it is especially these patients who can give vent to the terrific ructus. Some patients only make repeated movements of swallowing, " dry swallowers," in order thereby to increase the pressure in the œsophagus and get the food to glide downwards.

Not all patients are sharp enough to discover these manœuvres, but they quickly perceive their value when they have once learned them (Cf. Case V).

As will be seen from this description, all the various movements to which the patients resort are on the whole intended to increase the intrathoracic pressure, and thereby also the pressure in the œsophagus. The same applies to the copious draughts of fluid or the swallowing of air, whereby the œsophagus is distended. Stretching of back and neck help in their way towards a partial straightening of the too long and crooked œsophagus, so that the axis of lumen is more correctly situated with regard to the opening in the diaphragm.

Many of the patients are pronounced neurasthenics, others by no means so. In the case of many of them it is undoubtedly a fact that their swallowing movements are greatly influenced by external conditions; the presence of strangers, physical and mental strain, sorrows and other anxieties of all kinds, and even the thought of not being able to carry out the usual manœuvres, may augment the trouble to such a degree that for the moment they can get nothing down. The fact that difficulty in swallowing thus varies with purely exterior circumstances is regarded by many as a proof that the disease of the œsophagus is also in direct causative connection with a general neurosis.

In some cases, there also suddenly occurs, without demonstrable outer causes, a *complete stop;* in spite of all tricks not even a drop of water enters the stomach. Everything that the patient tries to get down is sooner or later disgorged. Indeed, the longer the complaint has lasted, the greater the risk of the appearance of this serious complication. Such a complete hindrance of the reception of nourishment may last at least a whole day, and even many days, so that the position may be so precarious for the patient that, in order to save his life, it is necessary to resort to gastrostomy or jejunostomy (Cf. Case I).

If we examine a patient during the act of swallowing, we hear at the usual time the first sound of swallowing at the neck or at the upper part of the back. The second sound of swallowing, on the other hand, fails to appear, either entirely, or is delayed, or has an altered character; we hear several sounds, one after the other, like water dripping into a filled decanter, or one or several such sounds may be produced by commanding the patient to make "dry" swallowing movements, for thereby the contents of the œsophagus can be transferred into the stomach.

On account of their strange behavior during meals, the patients soon begin to feel that they are unfortunately situated socially. They are shy of appearing at parties, and if nevertheless they allow themselves to be persuaded to do so, they eat at home beforehand and merely trifle with the food for fear of the consequences. As a general rule they are unwilling to eat with anyone but their nearest relatives, and often not even with them, since they take from half an hour to one hour over an ordinary meal.

Certain symptoms require further description.

The vomitings are not such in the usual meaning of the term, but typical

œsophageal disgorgements that occur in the midst of a meal or soon afterwards, without previous sensations of nausea and without any trace of strain. It is often sufficient to produce them if the patient assumes a horizontal position. They consist of unaltered food, more or less profusely mixed with slime and spittle. The reaction is neutral, slightly acid or alkaline, but HCl is entirely absent. If the dilatation is great, the disgorgements need not occur just after food, but may take place long afterwards, and may partly consist of food from one or more days before (Cf. Case II). In these circumstances the vomit may be decomposed and malodorous.

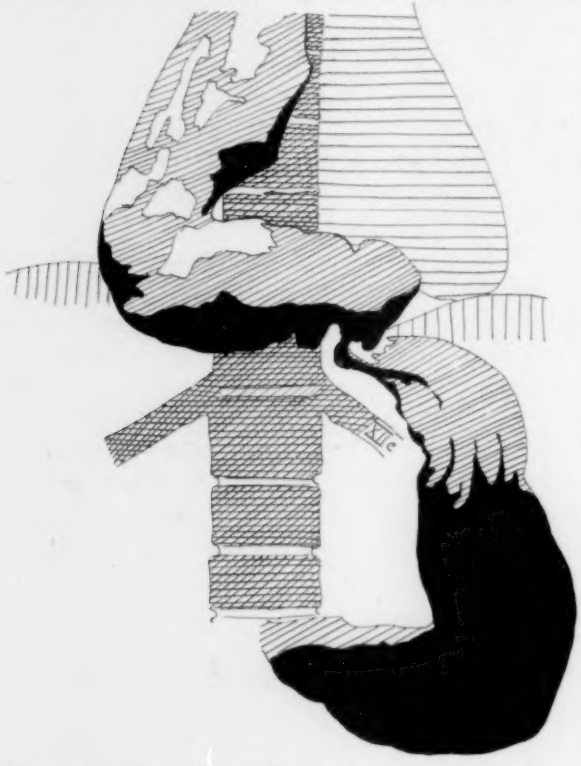

FIG. 7.—Case II. Nine months after the œsophago-gastrostomy. Photo taken immediately after the patient had drunk barium-milk.

The disgorgements at night may be the most troublesome, for the patient wakens one or several times with his mouth full of remains of food and of slime, so that, in order not to be choked, he has to get his head beyond the edge of the bed in all haste. There are patients, who for this reason, place a chamber or bucket just near their bed before they retire at night. In less pronounced cases the patient awakens every morning with his pillow soiled with food and slime. Both disgorgement and soiling are caused by the full œsophagus simply "running over" during sleep. In order to secure rest at night, some patients require to lie very high with the upper part of the body, practically half sitting up in bed. In some patients the disgorgements occur as pure ruminatings, ruminatio, the patient swallowing the food again (Luschka) after it has risen into his mouth.

The disgorged matter may in rare cases take the form of larger or smaller hæmatemesis, produced by bleeding from ulcerations or varicose veins in the dilated and inflamed œsophagus. The cause of the hemorrhage may also be a secondary cancer of the œsophagus or a complicating peptic ulcer in the stomach.

The pains of which the patients complain are of various kinds: A drawing sensation of hunger or a feeling of emptiness in the epigastrium, probably

caused by the fact that the stomach really is empty; but at the same time the distended œsophagus behind the sternum can produce a feeling of overfullness. This sensation can be extremely unpleasant, accompanied by pains that may radiate between the shoulder-blades, and even the arms, neck and ears, and does not abate until the contents of the œsophagus are either brought up or down. On account of these pains a patient therefore often puts his finger down his throat, when he believes that the contents of the œsophagus will not go down. Many patients feel less pain when the œsophagus is not quite empty (Cf. Case III); therefore do not quite remove all the contents if rinsing takes place, or they again drink a little after the rinsing is completed.

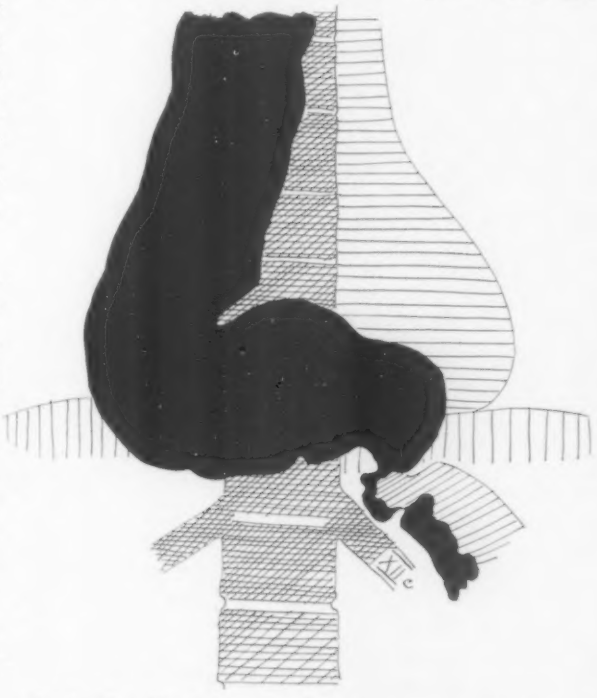

FIG. 8.—Case II. Same as Fig. 7, but taken immediately after opaque porridge.

The pains may increase to attacks of very marked sensations of oppression and cyanosis and a feeling of being choked, or they are accompanied by pronounced difficulties of respiration. These attacks may occur at definite times of the day and night, *e.g.*, in the afternoon (Bard), or during the night, and may then be mistaken for real asthmatic attacks. That they are really due to an overfilled œsophagus is evident from the fact that they abate during repeated belching or they disappear at once after the œsophagus has been rinsed. Not a few patients also complain of a sensation of constriction in the throat, most of all, perhaps, at the commencement of the illness. These pains are presumably due to reflex spasms in the uppermost constrictor or in the muscles of the pharynx. Others may have the feeling that a foreign body is in their throat.

The insufficient supplies of food and liquid often cause, in addition to emaciation, a marked sensation of thirst and persistent obstruction. The latter may also be a symptom of gastrocoloptosis, a complication that, it was found many years ago (*e.g.*, Stern, 1876), might be present at the same time as dilatation of the œsophagus.

One remarkable, and at times extremely distressing, symptom is an intense hiccough that occurs during meals or at night. Sometimes the hiccough is

the first symptom of the disease, and it may even occur daily for months at a time in conjunction with meals, and before the patient has noticed any dysphagia. But it may also occur during the later stages. It ceases when the œsophagus is emptied.

Amongst other complications may be mentioned an irritating dry cough, produced reflexly from the œsophagus, somewhat similar to "stomachal abdominal cough"; or if it occurs at night—and this is often the case—it is undoubtedly due to the fact that the contents of the œsophagus run up into the pharynx and directly irritate the ligamenta aryepiglottica, or threaten to enter the larynx.

We often find increased secretion of saliva, produced reflexly from the œsophagus.

The clinical history of the disease is often so characteristic that it is possible from that alone to make a correct diagnosis with great probability. This may be confirmed by examinations with probes, Röntgen rays and œsophagoscopy.

For the examination there is employed in some cases a flexible stomach tube, in others solid bougie. By inserting the stomach tube to a length of 20 or 30 cms. it may happen that remains of food are emptied out, either through the tube or at the side of it, without the patient actually vomiting, giving the observer the impression that the contents are derived from the œsophagus, which view will be confirmed if the contents give a neutral reaction and are badly digested. It is a proof that the substance first aspired comes from the œsophagus if, on pushing the tube further down, 40 to 50 cms., material is withdrawn which appears to have been well digested, giving an acid reaction, with positive HCl reaction, *i.e.*, the contents of the stomach. It has thereby been ascertained that above the stomach there exists a hollow cavity where food stagnates; but doubt may still exist as to whether this cavity is a diverticulum or a diffuse dilatation of the œsophagus. In order to decide this question the Röntgen rays and œsophagoscopy may be resorted to.

If we investigate with solid probes, it is best to employ blunt probes that are filled with lead or mercury. If we attempt to put the probe right down into the stomach, the results will vary greatly; the same applies, however, to the stomach tube. At the usual distance from the teeth, 40 cms., there may be felt a variable degree of resistance. Both tube and bougie may pass into the stomach without difficulty; in other cases there is felt at the cardiac orifice a distinct resistance, which at first cannot be overcome, but which suddenly gives way under careful, steady pressure with the probe. If it is difficult to get the probe to pass, it may happen that it slips down if we cause the patient to vomit, during which the cardia is opened, and take care to push the probe down at the same moment. Patients, who are accustomed to use a probe themselves are often more expert than the surgeon in finding a way into the stomach. Not rarely we have to abandon all attempts to overcome the resistance met by the probe. The obstacle, however, need not be situated in the cardia, for it may be that the probe strikes against the wall of the distended œsophagus (Cf. Case II, Fig. 4). As the œsophagus is often longer than the normal and is bent sharply towards the right, it must be remembered that it may be necessary to insert 50 to 60 cms. of the probe in order to reach the stomach. It is frequently possible without appreciable difficulty to insert 60 to 70 cms., and we feel quite convinced that it must be in the stomach until a Röntgen examination demonstrates that the probe has merely curled up in the dilated œsophagus (Cf. Case V, Fig. 19).

All kinds of probing examinations have however lost diagnostic importance in comparison with Röntgen rays and œsophagoscopy. Yet we cannot deprive the probe of a certain value in preliminary orientation. Inter alia, we may also, when the diagnosis has

been ascertained, employ the stomach tube for approximate measurements of the capacity of the distended œsophagus. The œsophagus is first rinsed clean, and we then investigate the amount of water that can be poured into it. The results are of course unreliable if the water is expelled before the œsophagus is filled.

Röntgen investigation is the simplest method of securing clearness as to the size and shape of the œsophagus, the dimensions and duration of its retention, the seat of the obstacle, the situation of the cardia, and the function of the muscular coat and of the cardia, and also the function of the latter. In investigating we should employ both contrast porridge and contrast fluid; we investigate both in the frontal plane and in the oblique plane, the results thereof supplementing each other. It is seldom possible to obtain a true copy of the entire œsophagus, as the porridge usually collects in the lowest two-thirds or three-quarters, whilst in the upper part we only see the precipitate from the contrast meal on the walls of the œsophagus, in some cases in the form of distinct, longitudinal stripes. (Cf. Case II, Fig. 3) The following are characteristics of idiopathic dilatation of the œsophagus:

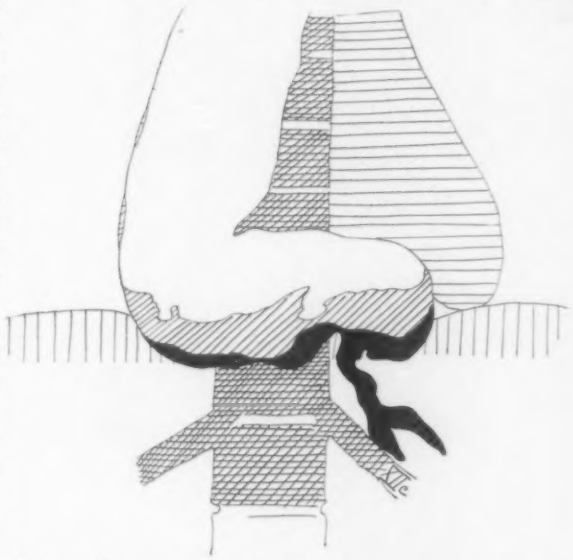

FIG. 9.—Case II. Same as Fig. 8, but taken two and one-half hours after the meal.

The œsophagus is found to be larger than usual, especially broader but in many cases often longer. The dilatation commences at the pulmonary hilus, jugulum, or even right at the cricoid cartilage. The most characteristic part of the dilatation, however, is almost always below the root of the lung. The shadow of the œsophagus has sharp outer contours, without indents or projections. It is either spindle-shaped with its greatest diameter 5 to 10 cms. above the diaphragm, or it is more or less even the whole way with a rounded lower end, *i.e.*, *sausage-shaped*, or the dilatation increases steadily downwards in order to end abruptly just above the diaphragm or cardia, *i.e.*, it is bottle-shaped or pear-shaped. The shadow of the œsophagus almost always shows a distinct convexity towards the right, so that its right edge extends to the point of the right proc. transversi or past the latter, and even far beyond them. Just above the diaphragm, however, there is sometimes demonstrable an outward rounding with convexity to the left, short but sharply marked. (Cf. Cases II and V, Figs. 4 and 20.) When the œsophagus is not only dilated but is also too long, the elongation is seen very distinctly in the X-ray photogram the œsophagus then forming a large S-shaped curve towards the right in the direction of the sinus pleuræ, and thereafter continues upwards towards the left along the right half of the diaphragm to the hiatus; the œsophagus as it were coils up on the diaphragm (Cf. Cases II and III, Figs. 3, 4, 9 and 12).

The form may also otherwise differ from the usual one on account of sharp bends or extra dilatations. One of my patients exhibited a distinctly saucer-shaped distention, corresponding to the bifurcation, above and to the left of the physiological constriction at that place. (Cf. Fig. 12) Leffler and Bertolotti and Boidi (quoted from Goudet) have described a typical idiopathic dilatation combined with a diverticle of the œsophagus as large as an apple, corresponding to the superior lobe of the right lung in both cases.

The lower end of the X-ray shadow often has a highly remarkable appearance,

either ending in a conical process or is rounded like the end of a sausage, separated from the stomach shadow by a defect 2 to 4 cms. in length. We often see that from the blunt end there runs out a short point like a bird's beak or a thin, narrow stripe of shadow, that from its appearance and relation to the main shadow can be characterized as a radish, a mouse's tail or a pig's tail. If there is a distinct defect between the œsophagus and the stomach, we may produce the "radish" or even a connection as much as a little finger between the œsophagus and stomach, by causing the patient to draw a deep breath and to strain himself.

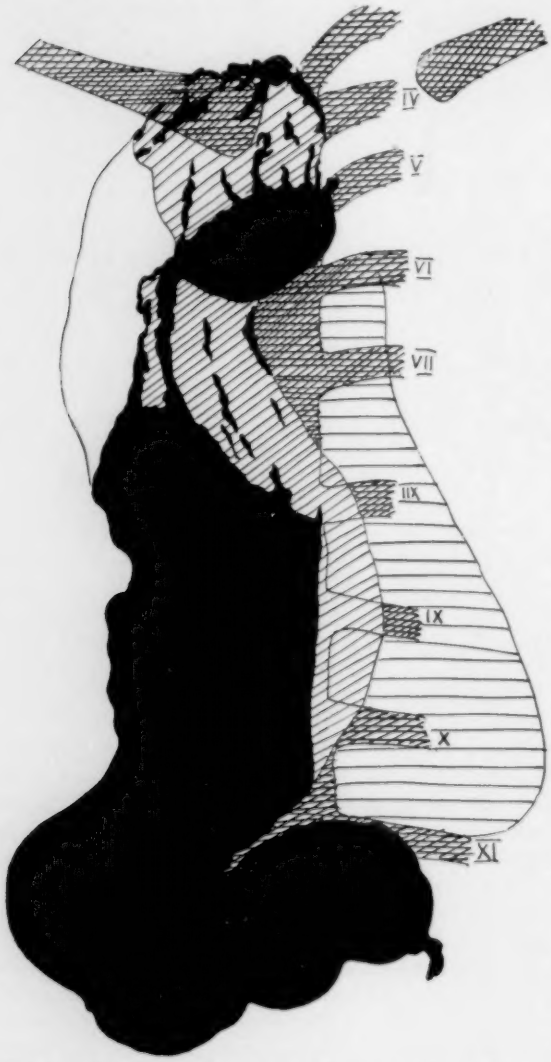

FIG. 10.—Case III. Before the œsophago-gastrostomy. Photo taken immediately after opaque meal.

In some cases by transillumination it is possible to see more or less pronounced peristaltic movements of the wall of the œsophagus. In others it appears to be a slack bag, or we see the peristalsis from the normal parts of the œsophagus lying above disappear into the walls of the distended part. The contents of the œsophagus often show very distinctly the pulsation of the heart. If we are fortunate, we can see the whole or greater part of the contents enter the stomach at once. Or the discharge takes place successively.

The dimensions and duration of the retention are easy to ascertain by transillumination or photography from time to time in the course of the first twenty-four hours, or if necessary longer. During that time of course the patient must not eat or drink. The retention after contrast porridge may last up to twenty-four hours (Cf. Case II, Fig. 5) or more; after barium water the retention is not so lengthy as after porridge. As contrast porridge can scarcely be regarded as a physiological meal, we should not at once transfer the results obtained after consuming the same to other ordinary articles of food. It may well happen that the "Röntgen retention" is greater and more lasting than "food retention." One of my patients (Case IV) stated positively that she felt more uncomfortable after barium porridge than after her daily fare.

In order to ascertain the exact situation of the obstacle it is necessary, after a special observation of the cardial region, to undertake several transilluminations and take several pictures of that region. The examination must be made in various planes, during various phases of respiration, and with or without strong straining on the part of the patient.

I cannot boast that my patients have been sufficiently exactly examined with this precise aim in view. I am therefore also unable to say definitely from the X-ray photograms whether the obstacle in my cases is situated just above or below the diaphragm.

Œsophagoscopy. Before the examination, the œsophagus must be rinsed quite clean. Spasms at the œsophageal introitus sometimes form an obstacle to the introduction of the instrument. As soon as the latter has reached as far as the distended part of the œsophagus, it is at once perceived that an unusual cavity is present. The instrument can without difficulty be moved to a considerable extent in all directions, the walls are noticeably slack, so that they form hanging folds and may even "flap like the sail of a boat when tacking." (Tetens Hald.) In spite of previous rinsing, we can see slime and the remains of food along the walls of the œsophagus. The mucous membrane is pale and smooth, or thickened with distinct plaques, or injected with fraying and exfoliations of the epithelium, or it exhibits larger or smaller distinct ulcerations.

The condition of the cardia in the œsophagoscopic picture is variously described by different authors. Hugo Starck considers that it is difficult in general to recognize a spasm at the cardia directly in the œsophagoscopic picture. Proofs of the presence of a cardiac spasm are more indirect: lack of alteration of lumen during inspiration and expiration, lack of slime that gushes forward and the firm closing of lumen. The fact that the tube does not go down into the stomach need not be a proof that the lumen is closed; this may be due to erroneous technic.

According to Guisez's view, there is no real sphincter corresponding to the cardia, but the contraction takes place at a level with the hiatus œsophagi or canalis cardiacus, *i.e.*, the narrow part of the œsophagus extending from the hiatus 2 cms. downwards. In extreme dilatations it is not possible to pass the cardia at once with instruments. If we attempt to force a way through the cardia juts forward into the œsophagus, like a portio uteri. By the use of cocaine and continuous slight pressure it is not difficult to get down into the stomach. Later on in the disease it may be impossible on account of secondary stenosis.

American writers, such as Mosher and Chevalier Jackson perhaps hold a similar view when they consider that in idiopathic œsophagus dilatations by means of œsophagoscopy they can demonstrate a constriction of lumen corresponding to the "liver tunnel," *i.e.*, the subdiaphragmatic part of the œsophagus where it is bordered by the left lobe of the liver, to the right and in front.

Prognosis.—"Das Leiden ist für den Kranken keine anatomische Spielerei," says Rumpel, and I can agree with him. When once the disease is fully established, the patient usually becomes steadily worse, unless proper treatment is given in time. The rapidity whereby the disease becomes worse, however, varies greatly in different patients. Some die of inanition in the course of some months (Strümpel), others survive with the disease for decades, even up to fifty years and more (Batty Shaw). In my five patients the disease had lasted for ten years, eleven years, twenty-five years, twenty-eight years and thirty-four years. But even if the patients usually live for many years, the influence of the complaint upon their general condition varies greatly. Some may get along quite well and be entirely able-bodied, others in a sense live, but insufficient nourishment in connection with pain and disturbed sleep at night considerably reduce their general condition. This is quite evident from the great increase in weight that results from successful treatment even in the case of patients who have suffered for years.

The most important complications are:

1. *Cancer œsophagi* is stated to occur in as many as 7 per cent., and even in comparatively young individuals.

2. *Hæmatemeses*, either from ulcerations or broken veins in the œsophagus itself, from cancer œsophagi or from a complicating ulcus ventriculi.

3. *Perforation* as a consequence of probing, by the physician or by the patient himself. Spontaneous perforation doubtless only arises in secondary cancer.

4. *Pulmonary Tuberculosis.*—If the patient is left entirely to himself and is not carried off by complications, death will occur as a result of inanition. That termination is fortunately now rare, as by degrees the appearance of the disease has become better known, but it still occurs. A correct diagnosis at a comparatively early stage with the consequent correct treatment will in the majority of cases give hope of achieving a complete clinical cure. Even in neglected cases an eventual operation may work wonders.

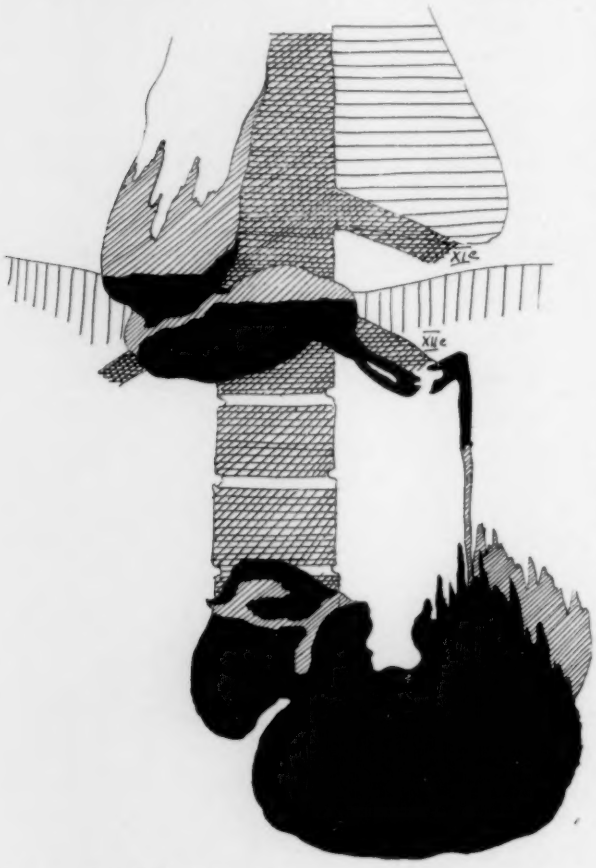

FIG. 11.—Case III. Five weeks after œsophago-gastrostomy. Photo taken one-half hour after opaque meal.

The diagnosis is mainly based upon history of the case, patient's manner of eating, and result of examinations with probes, Röntgen rays, and œsophagoscopy all of which have been sufficiently discussed under the heading symptomatology.

Several causes explain the many erroneous diagnoses recorded in literature. In the first place the disease is relatively rare and the clinical picture, in spite of its remarkably characteristic form, is not generally known. In the next place the physician does not attach sufficient importance to the patients' decided statements that the food "stops up." In order to obtain an idea of the difficulty in swallowing, we must not restrict ourselves to submitting the patient to the usual drinking test with a glass of water, in order to see whether he empties it without taking the glass from his mouth or not. Many of these

patients by no means drink in gulps. The large œsophagus is so roomy that without difficulty they can quickly empty glass after glass exactly like other people, provided the œsophagus is not full beforehand. The patient must be allowed to give a thorough description of the manner in which he eats, and must take a meal in the presence of the physician. It is characteristic of idiopathic dilatation of the œsophagus, but unfortunate for the diagnosis, that it is not rarely complicated by other complaints, which are taken to be the essential ones, whilst the complaint in the œsophagus is overlooked.

In the case of children, the remarkable way of eating is regarded by relatives and also often by the physician consulted as an outcome of unpleasant habits and bad manners, of which it is hoped in the course of time to free the child, or which it will "grow out of."

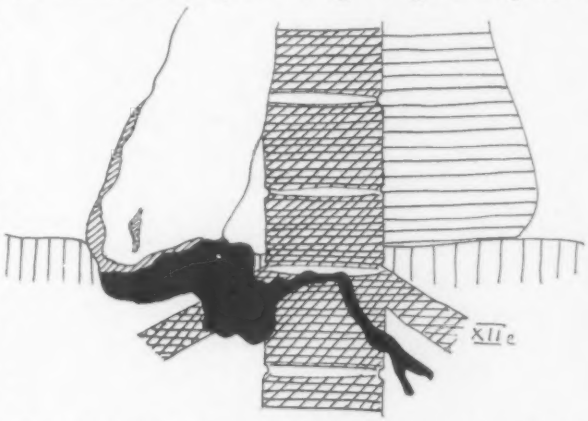

FIG. 12.—Case III. Same as Fig. 11, but taken four hours after opaque meal.

When nervous symptoms appear prominently in addition to vomiting, the whole is regarded as a grave form of hysteria or neurasthenia. The real hysteric spasms of œsophagus may be found everywhere in the gullet; they never lead to very large dilatations of the œsophagus.

The frequent copious and intractable vomitings in connection with loss of weight cause both the stomach specialist and the surgeon to think of pyloric stenosis; in several cases explorative laparotomy has been made, and in spite of the negative result as to the stomach, surgeons have performed gastro-enterostomy, or—to greater benefit of the patient—gastrostomy on an incorrect or unknown diagnosis. If hæmatemesis occur, it is easy to stumble over the diagnosis gastric ulcer, a complication that moreover has been demonstrated several times. Obstipation may be very prominent in these patients. If therefore gastro-enteroptosis is demonstrated by means of the Röntgen rays—and this is not unusual amongst such patients—it may be regarded as the real complaint of the patient, whilst the disease in the œsophagus is overlooked, or is regarded as secondary and produced by the gastroptosis.

If the disease commences or is aggravated during pregnancy, it may be regarded and treated as hyperemesis, which on account of its persistency, has in some cases resulted in artificial premature labor, of course without any appreciable effects upon the condition of the patient.

The continuous cough has in some cases given rise to the diagnosis pulmonary tuberculosis. This diagnosis is specially liable to be made in those rare

cases, where a complicating diverticulum of the œsophagus is accompanied by physical symptoms of a pulmonary cavity (Leffler). Attacks of dyspnœa occurring regularly may be regarded as real asthma before it is observed that they are dependent upon meals. A dulness of the right surface of the back caused by a slack œsophagus filled with liquid has given rise to a mistaken diagnosis of pleurisy, and has therefore led to a trial puncture (Cordier, quoted after Goudet), with the specially surprising result for the examiner that the syringe was filled with a fluid smelling of wine and food. Even if the patient survived, and the true diagnosis was made by the aid of a trial puncture, succeeded by a Röntgen examination, very few will maintain that this took place in the least dangerous manner as far as the patient was concerned. Several patients, on account of the pains localized in the throat, in connection with thirst, have been treated for chronic catarrh of the throat by painting or tonsillectomy (Cf. Case III).

I must dwell a little longer upon the differential diagnosis in respect of other diseases of the œsophagus, especially as regards those which are accompanied by stenoses, with more or less marked dilatations. It is here necessary first to premise the remark that the majority of complaints of the œsophagus, irrespective of their nature, can be accompanied by spasmodic contractions, especially corresponding to the upper and lower end of the œsophagus, but also at any part of its course. These spasms give rise to dysphagy, pains and disgorgements, *i.e.*, symptoms that are also found in idiopathic dilatation of the œsophagus. The cause of these spasms may be the various pathological anatomical conditions, *e.g.*, a polyp, an ordinary ulcer, an œsophagitis, a peptic ulcer in the œsophagus, or a cancer. All these conditions are usually demonstrable by the aid of the œsophagoscope, which especially for the purposes of differential diagnostic is of great importance. If an ulcer is small and cannot be observed through the œsophagoscope, because it is hidden behind the folds of the mucous membrane, it may appear to be a case of primary spasm. Whether marked dilatation of the œsophagus may develop on the basis of this is a disputed point, as to which I must refer to the section devoted to pathogenesis. As to those complaints of the œsophagus concerning which mistakes can most easily be made, an elderly person with dysphagia naturally leads us to think of cancer, which moreover is the most frequent of all complaints of the œsophagus. The Röntgen photogram in primary cancer of the œsophagus never shows such marked dilatations as in idiopathic dilatation, and there are distinct defects in the shadow picture, either at the edge only or more or less intensive ones. The seat of the obstacle is rarely exactly the same as in idiopathic dilatation of the œsophagus (Cf. Figs. 22–24, all from cancer œsophagi). Œsophagoscopy usually clears up the matter; in cases of doubt certainty is obtained by trial excision. Before this has taken place, differential diagnosis may sometimes be quite difficult, partly because a cancer œsophagi now and then last two or three years (Karewski), partly because the röntgenogram may sometimes be unlike what is expected, and finally in some cases because cancer not rarely occurs secondarily in an idio-

pathically dilated œsophagus, even in young individuals (Cf. Troell's patient, twenty-seven years old).

In caustic stricture the history of the complaint and its localization are characteristic, and the dilatation never excessive. The congenital strictures are very seldom and show a characteristic more or less membranous stricture by œsophagoscopy.

On account of the lengthy history of the complaint and the clinical symptoms, diverticula may give rise to confusion. The majority of diverticulæ proceed from the posterior wall of the pharynx, just at the transition to the œsophagus, and will therefore give an entirely different Röntgen picture. The entrance to the diverticle can be directly shown in the œsophagoscope. Diverticula in other parts of the course of the œsophagus are rare, especially large diverticula. The greatest difficulty in a diagnostic respect is caused by the deeply-seated ones, epiphrenal or supra-diaphragmatical—as their localization coincides with the spot where the dilatation is often greatest, also at the diffuse dilatation. Fortunately the deeply-seated diverticula are a rare complaint, it being said that only twenty-one certain cases of this are known (Dessecker). The majority of those previously described, have undoubtedly been idiopathic dilatations. The Röntgen picture decides the diagnosis here, too, for we find a round shadow lying as a rule to the right of the lower end of the œsophagus.

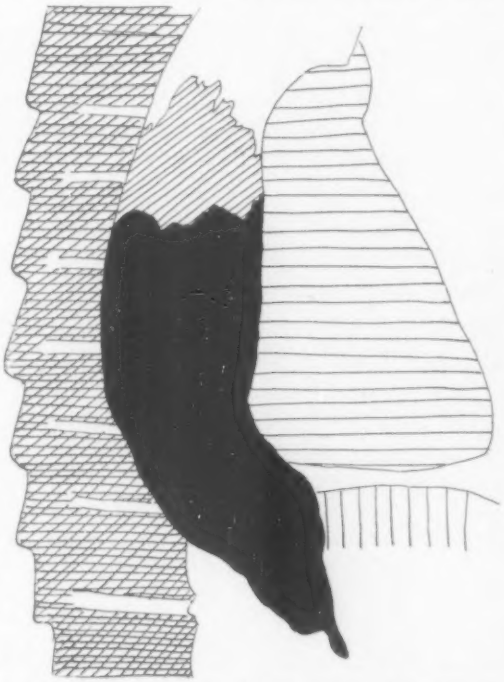

FIG. 13.—Case IV. Before the œsophago-gastrostomy. Photo taken immediately after opaque meal. Oblique plane.

Atony of the wall of the œsophagus, *e.g.*, after diphtheria, may give rise to dilatation of the œsophagus. But atony alone will scarcely give rise to difficulties in swallowing, at least not as long as the patient sits or stands. Peristaltic contractions are lacking in Röntgen transillumination. The distention is even and not great. Hernia diaphragmatica with the stomach dislocated in the thoracic cavity might give symptoms that reminded one of dilatation of the œsophagus; but as a rule the vomit contains HCl, and the Röntgen picture will show that the stomach lies in an abnormal place. Tumors in the mediastinum may by compression of the œsophagus produce a pronounced dysphagy with vomiting. The same is the case with *aorta-aneurism*,

which it may be of practical importance to remember, as in these conditions œsophagoscopy may produce rupture of the aneurism. We must therefore never employ œsophagoscopy before a Röntgen examination has been made, when there is present a dysphagy of unknown cause (Sargnon).

Age and Sex.—Idiopathic dilatation of the œsophagus occurs at all ages and in both sexes. Thieding found by combining a number of earlier statistics with those prepared by himself, that out of 246 cases, 157 were men, *i.e.*, 64 per cent. I have collected 158 cases from medical literature, and of these 84 were men (*i.e.*, 53.2 per cent.) and 74 women (*i.e.*, 46.8 per cent.), which agrees with the circumstance that the majority of statistics exhibit some preponderance of men.

It is stated that the complaint occurs most frequently at the age of thirty or forty. As, however, it very frequently has a markedly chronic course, it is of the greatest interest with regard to the pathogenesis, to ascertain how old the patient was at the commencement of the complaint. It must be admitted that in many cases it is difficult to determine this date, for the disease often commences very insidiously, so that it is not until years afterwards that the patient consults a physician. We may therefore assume that in reality the commencement lies farther back in time than the date given by the patient. Of course much here depends upon the care with which the patient is examined.

In order as far as possible to ascertain this fact, I have investigated the age at which the disease commenced in 141 patients; the following table shows the result of the various periods of five years:

TABLE I

Showing the Age of 141 Patients at Commencement of the Disease

Age	Men	Women	Sex not stated	Total	
0– 5 years	3	0	1	4	1st decennium 11,
6–10 years	5	2		7	*i.e.*, 7.8 per cent.
11–15 years	16	11		27	2nd decennium 55,
16–20 years	13	15		28	*i.e.*, 39 per cent.
21–25 years	11	10		21	3rd decennium 35,
26–30 years	6	8		14	*i.e.*, 24.8 per cent.
31–35 years	6	6		12	4th decennium 26,
36–40 years	8	6		14	*i.e.*, 18.4 per cent.
41–45 years	3	3		6	5th decennium 11,
46–50 years	2	3		5	*i.e.*, 7.8 per cent.
51–55 years				0	6th decennium 2,
56–60 years	2			2	*i.e.*, 1.5 per cent.
66–70 years	1			1	7th decennium 1, *i.e.*, 0.7 per cent.
Total	76	64	1	141	

It appears from this table that in the great majority of cases, 116 out of 141, *i.e.*, 82 per cent., the disease commenced at the ages of ten to forty years;

but there is an unmistakable maximum for the first part of that period, ten to twenty-five years, there being 76 patients, *i.e.*, 54 per cent. In other words, in more than one-half of all the cases, the patients were between ten and twenty-five years when the complaint commenced. Further, it should be noticed that the second decennium alone presents 39 per cent., far more than any other period of age.

Pathogenesis.—The most important fact of the clinical picture is that the œsophagus does not empty into the stomach in a normal way. The difficulty in pathogenesis is to prove, why it is not able to do so.

If we assume that this defective discharge is due to a mechanical obstacle of some kind or another, then all other alterations in the œsophagus and in the general condition may easily be explained as secondary; dilatation, hypertrophy of the wall of the œsophagus, œsophagitis, ulcer, cicatricial stenoses, nerve irritability, and indeed even spasms at the introitus or cardia. On the other hand, we have an entirely different view of the pathogenesis if we accept any of the alterations here mentioned as the primary cause and say that the dilatation is due to one or another of these.

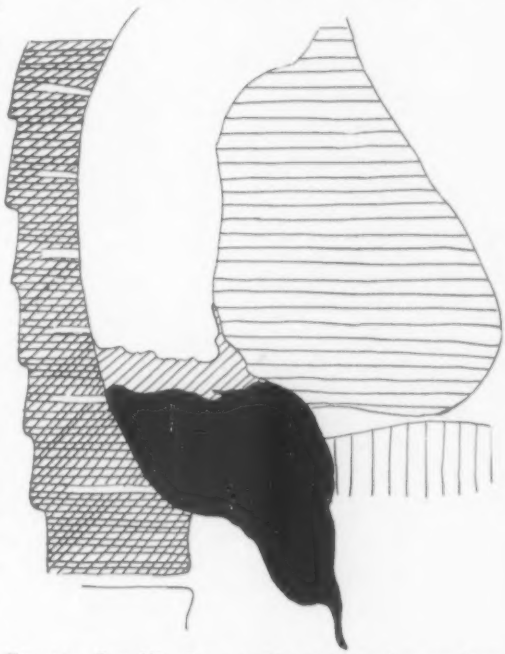

FIG. 14.—Case IV. Same as Fig. 13, but taken one hour after opaque meal.

Attempts have been made to apply to idiopathic dilatation of the œsophagus every conceivable explanation as to why a muscular hollow viscus does not empty itself in the usual way.

The hypotheses that have been put forward can be divided into these groups, according to whether the cause of the dilatation is presumed to be due to: I. *Acquired functional disturbance in œsophagus or cardia.* II. *A mechanical obstacle.* III. *Congenital disposition or malformation.* IV. *Trauma.*

I. *Acquired functional disturbance in œsophagus or cardia.*

(*a*) A disfunction of cardia may conceivably in three ways prevent the œsophagus from discharging its contents into the stomach: either there is an increase in the normal tonus of the cardia, *i.e.*, a spasm, or the cardia is not relaxed because the reflex inhibition is absent, or because the action of the longitudinal muscles is not powerful enough to open the cardia.

Strümpel (1881) mentioned spasm in the cardia as a possible explanation, but rejected it as far as his own case was concerned. Mikulicz (1882) was the first to consider that he had demonstrated the contraction of the cardia

by the œsophagoscope. More than any other he helped to spread the spasm theory, and he also put a label upon the complaint that it still most often bears, *viz., cardiospasmus*. But he was by no means the first to believe that the dilatation is due to a spasm in the cardia. Amongst others *Cruveilhier* is said to have made statements in that direction. In the North, a Swedish surgeon, *M. Huss*, as early as 1842 expressed exactly the same views in connection with the case clinically observed by him in a lady forty-two years of age, and who subsequently was dissected. As I consider that Huss deserves to be rehabilitated, I will quote his arguments: "If spastic constriction of the cardia occurs at the same time that more solid food is swallowed, and causes a stoppage there, this food will during its passage cause irritation and for varying periods maintain spasms. If this is often repeated the tissue above the constriction is relaxed, becomes yielding, and is constantly further dilated. *Assuming this, viz., that the spasm in the cardia has been the primary and the dilatation the secondary cause, the case can thus be explained.*"

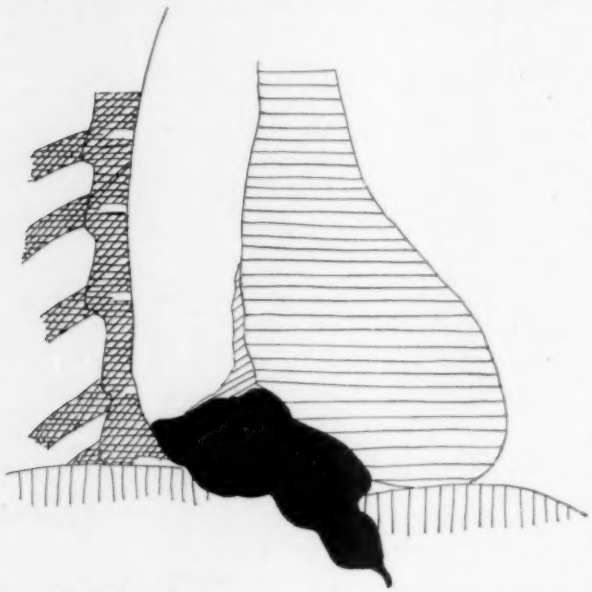

FIG. 15.—Case IV. Same as Figs. 13 and 14, but taken eight hours after opaque meal.

In 1888, S. G. Meltzer put forward the view that, when inhibition is absent, the cardia had to be so strongly restricted that the contractions of the œsophagus could not overcome the resistance. This variation of the spasm theory was again adopted by Rosenheim (1897), by Sencert and Mathieu (1913) and by Hertz, practically simultaneously. To the last named we also owe the name "achalasia cardiæ," or defective power to relax the cardia.

In order to explain how spasms can produce dilatation, it is assumed that at first it occurs rarely, but by degrees becomes more frequent and finally is practically permanent for years. Guisez and several others maintain that in conjunction herewith there occurs hypertrophy of the muscles, and a secondary, chronic inflammation with development of fibrous tissue, so that at last the obstacle also becomes an organic one.

In support of the spasm theory we have besides the results of probing (narrow passage, feeling of spasmodic contraction around the probe) and œsophagoscopy, the fact that there are also parallels from other parts of the body, *e.g.*, spasm of sphincter ani with fissure, or congenital spasm of the pylorus.

Whether we regard spasm in the cardia or lack of relaxation as the decisive factor, in both cases the disfunction is assumed to be of reflex origin. The origin of this reflex is ascribed to the œsophagus in inflammatory lesions or ulcerations in its lower part. These inflammations or ulcer formations are said to be the result of rapid eating and bad mastication, and the swallowing of too large pieces of food, or the result of the abuse of tobacco and alcohol. But the reflex is also said to arise from an abdominal complaint, *e.g.*, peptic ulcer, gall-stone, appendicitis, gastro-coloptosis, complaints in the female genitals, etc.; and then mostly in individuals who are highly nervous or hysterical. Indeed, some consider that spasm of the cardia in individuals of that kind can be of a psychical character and need not be due to a reflex from an organic complaint. Even if the spasm is secondary, it may clinically give the impression of being primary because we cannot see in the œsophagus the little ulceration that is the starting point of the trouble, or because it is not possible to discover the origin that is situated in an entirely different part of the body.

Very important objections may be raised against the spasm theory and the "achalasia" respectively. Even in the most obstinate and long-standing organic strictures, *e.g.*, caustic strictures, we never find anything approaching these marked dilatations. It would therefore be remarkable if a spasm, which from its nature must be assumed to vary, and thus does not form any permanent obstacle, should produce more pronounced dilatations than an organic stricture. In addition there is the fact that the sphincter cardiæ is doubtless the weakest of all the sphincter muscles, and it would be remarkable if precisely this one should be able to keep contracted for years and produce such a large dilatation, that the like is not otherwise to be found produced by sphincter spasms elsewhere in the human body. I can therefore quite understand Thiroloix and Bensaude (quoted from Bard) when they endeavor to save the situation by "c'est un spasme très special, qui ne présente son analogie dans aucune autre région de l'économie," an assertion that "sounds well" but is quite unproved.

Neither spasms of the sphincter ani, nor congenital pylorospasms occasion any appreciable dilatations of the rectum or the stomach, and both can be completely cured, merely by a diatetic régime, which is not the case with idiopathic dilatation of the œsophagus.

In a number of cases it has not been possible by the œsophagoscope to demonstrate any spasm (Starck), and in many patients the probe can always be carried directly down into the stomach with the greatest ease, and when this is not the case, it is rather due to sharp kinks and curves in the large œsophagus than to spasm at the cardia.

In those cases where cardiospasm really has been demonstrated, they are best explained as secondary and intermittent occurrences, either as the result of the examination—introduction of probe or œsophagoscope—or on the basis of the œsophagitis produced by stagnation of food. It is possible that the

aggravation that not rarely suddenly occurs in these patients, may be due precisely to such a secondary spasm.

The fact that so many patients at the commencement of the complaint are young, and further that many of them are women, is a strong argument against the contention, so frequently and always so confidently put forward, as to the great importance of tobacco and alcohol in producing "cardiospasm." It is another matter that abuse of them can aggravate the discomforts in those who already are suffering from the complaint.

If an abdominal disease by reflex can produce cardiospasm, it is to be expected that the symptoms of cardiospasm will disappear as soon as the suspected focus is radically healed by operation, *e.g.*, after appendectomy. As far as I know, there exist no clinical observations supporting this opinion.

FIG. 16.—Case IV. After the œsophago-gastrostomy. Photo taken forty-five minutes after opaque meal. Shows a distinct connection between œsophagus and stomach.

Because we sometimes find peptic ulcer, gall-stone, gastro-coloptosis, etc., associated with idiopathic dilatation of the œsophagus, it does not prove a causative relation; the said complaints are so common that it is more natural to assume that they are a coincidence rather than a connective cause.

Since these patients are markedly nervous and their discomforts increase with their mental state, so that adversity, sorrow, worries, in short, mental disturbances of all kinds, always occasion aggravation of the complaint, these conditions have been taken to prove that neurasthenia, not to say hysteria, is at the basis of the entire clinical picture. But this is far from being the truth. The clinical picture of many organic complaints, as peptic ulcer and gall-stone, is undoubtedly aggravated in the above-mentioned circumstances. The part played by mental disturbances in an organic complaint of the œsophagus was clearly shown in a case of cancer of the cardia reported by Knud Nicolaysen during a discussion at the Med. Selskap: "A man at a party makes an unpleasant remark to the patient, and suddenly the latter is unable to swallow anything; the same thing happens when one of his children is naughty at the dinner table."

There is every reason to believe that this kind of sudden aggravation of an organic complaint is due to a transitory spasm. Why should not the same apply to patients suffering from idiopathic dilatation of the œsophagus, so that their symptoms, too, are aggravated by psychic impressions, without it being necessary to argue therein any causative connection?

The fact that swallowing may temporarily be readily influenced by strong psychic impressions, has moreover been known for a very long time. Fr. Hoffmann (quoted after Thieding) says in his "de spasmis gulae inferioris et de nausea" (1773): spasms are produced by "wahnsinnige Liebe, ausschweifende Begierde," and further "Gemütserregungen hindern das Hinabgleiten der Speisen." But it is a far cry from this to the assertion that psychic impressions can produce a *permanent* obstacle to the reception of nourishment.

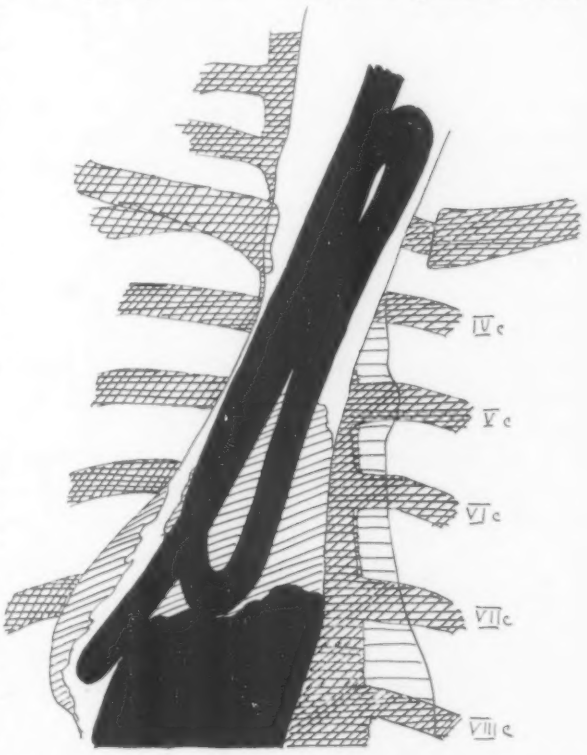

FIG. 17.—Case V. Shows how the œsophageal bougie is folded in three in the œsophagus.

If the nervous factor played such an important part, it would be natural that women would more often contract this complaint than men. The reverse is the case. In addition, clinical experience constantly teaches that many, perhaps the majority of these patients, cannot be regarded as neurasthenics. Is it not more reasonable to suppose, that where this complaint is found combined with neurasthenia, there is either a coincidence, or the neurasthenia is more likely to be a direct result of many years of suffering? As far as my patients are concerned, I must especially emphasize that some of them were distinguished by a well-balanced nervous system, sharp intelligence and sense of observation, and in some cases good temper, in spite of the daily discomforts of the disease; some also had even an indulgent smile for the physicians who had declared that the whole complaint was only due to nervousness.

Is there then no such thing as a cardiospasm? Undoubtedly yes, but it is intermittent, either secondary in any complaint of the œsophagus, or also primary as a symptom in general neuroses—globus hystericus is sufficiently well known. But these do not result in diffuse dilatations, and the clinical

picture, more especially the manner of eating as well as the X-ray photogram, differs from that of idiopathic dilatation.

(b) A disfunction of œsophagus, produced by *atony of the muscular coat*, according to Rosenheim (1897) occasions the same difficulty in discharging as spasm at the cardia. Such an atony can be primary, produced reflexly, may depend upon an œsophagus with inflamed infiltration of the muscular layer, or may be due to paralysis of the vagus. Cases of œsophagus atony are well known clinically, but it is very improbable that atony alone can result in diffuse dilatation. Provided there is not present at the same time any real obstacle to discharging, atony will merely cause a somewhat delayed discharge, a brief retention. For merely a slight increase in the pressure in the œsophagus, that is easily produced in an upright position, is sufficient to overcome the resistance of a normal cardia. On examining post-mortem idiopathic dilatation of the œsophagus, we almost always find the muscular layer thickened, and it is very rarely thinner than normally, as might be expected in atony.

It is another matter that atony can aggravate the symptoms when they occur secondarily in an already fully developed idiopathic dilatation of the œsophagus, where it may have been produced by overstretching of the wall, or where also secondary œsophagitis may have been a contributory cause. If the œsophagus lies like a slack, distended sack, it will be difficult for its tough, mucous contents to slide further, even if the opening is normal (Cf. F. P. Gregersen's experiments with a canvas model of the œsophagus).

Guisez employs atony in a strange argument. As mentioned above, he is a keen advocate of the hypothesis concerning cardiospasm with secondary inflammatory stenosis. As, however, even Guisez cannot deny the existence of large dilatations without any trace of stenosis at the cardia, he assumes that these cases are very old ones, and develop from the spastic cases, the spasm in the course of time being replaced by atony of the œsophagus and cardia. But then, what happens to Guisez's secondary inflammatory stenoses? Can they also disappear?

(c) Atony combined with cardiospasms would theoretically result in dilatation. Kraus considers that such was the case with his patient, and he believes that he found the cause in atrophy of the nervi vagi that he demonstrated simultaneously. This case, however, is unique and cannot be given any importance as regards the pathogenesis of all the other cases in which nothing abnormal in the vagi was found.

II. *The Dilatation is Due to an Acquired Mechanical Obstacle.*—This title contradicts itself; for, if a stenosis demonstrable pathologico-anatomically is the cause of a dilatation, it is no longer correct to speak of idiopathic dilatation. I must, nevertheless, devote some words to this, because a number of authors consider that the cause is to be found here.

All stenoses of known origin found in the œsophagus (cancer, lye strictures) never result in the diffuse dilatations that are seen in idiopathic dilatation. On the other hand, inflammatory stenoses have been shown in a

number of large dilatations (cicatrices, adhesions), or muscular hypertrophy in the lowest part of the œsophagus; but as to how or why these arose, we know little or nothing. Perhaps they are secondary, the result of the œsophagitis that often accompanies large dilatations; if so, they have no connection with the cause of the dilatation, but may conceivably aggravate the condition.

As early as in 1876 Stern, and in 1897 Wibrecht, drew attention to the circumstance that gastroptosis is encountered with dilatation of the œsophagus. At the German Surgical Congress in 1907, Czerny placed gastroptosis in direct causative connection with this complaint of the œsophagus, believing that tension from the sunken stomach renders difficult communication between œsophagus and stomach Rovsing (1913) is of the same opinion and believes that the kink occurs at hiatus œsophagi.

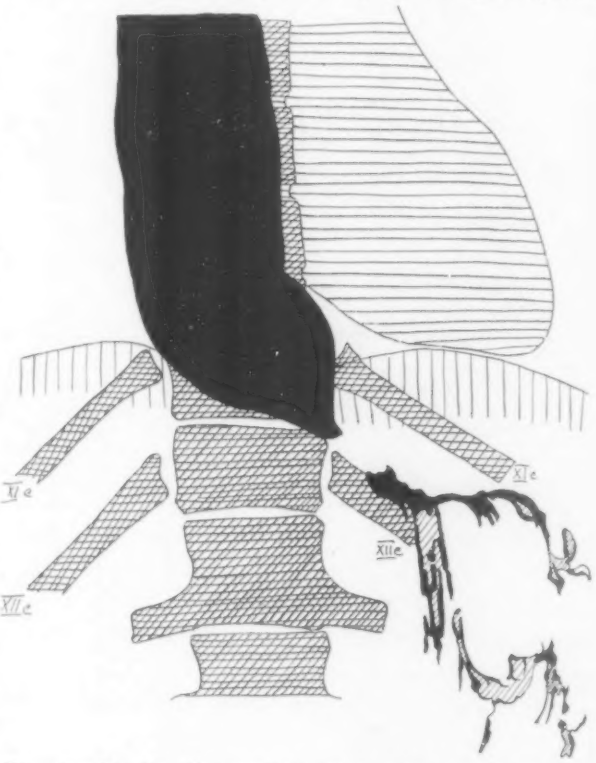

FIG. 18.—Case V. Not operated. Photo taken immediately after opaque meal. Ventro-dorsal plane.

III. *Congenital Predisposition?*—As in a number of cases at post-mortem examination, stenosis at cardia or pars abdominalis œsophagi was demonstrated (Chappet, Falkenheim, Rumpel), without macroscopical signs of inflammation, this stenosis has been regarded by some as congenital.

In 1857 Luschka described in the case of a man, fifty-four years of age, a sharply defined dilatation of the œsophagus, just under the diaphragm (called by Luschka, antrum cardiacum), 3.7 cms. high and 5 cms. broad, and in another case he found a similar dilatation just above the diaphragm, the so-called "Vormagen." Arnold has previously described three such "Vormagen," all "ruminating" men. Are these congenital anomalies, and can they conceivably form the origin of diffuse dilatation of the œsophagus?

More sympathy has been enlisted for quite another hypothesis, because it is applicable to the majority of cases. As early as in 1907, von Hacker at the German Surgical Congress expressed his doubts regarding cardiospasm; on the other hand, he drew a parallel between dilatation of the œsophagus and Hirschsprung's disease, and speaks directly of *megaœsophagus*. It is this

idea that L. Bard has further developed on a broader basis. Bard emphasizes that we have examples from the most different organs of congenital dilatations without any traceable obstruction. He herein includes, inter alia, megacolon, megarectum, megavesica, the so-called choledochus cyst, certain congenital hydronephroses, certain forms of hydrocephalus, etc. It is characteristic of all these diseases that the dilatation appears without previous pain, and is more pronounced than in any organic stricture. The complaint gives no clinical symptoms before the dilatation (or the elongation) becomes so great that *per se* it causes a mechanical obstacle to the dischargings of the organ concerned. There is thereby given a condition for stagnation and secondary inflammation, both of which again can increase inflammation. These diseases are never cured without operations that aim at an alteration in the mechanical conditions.

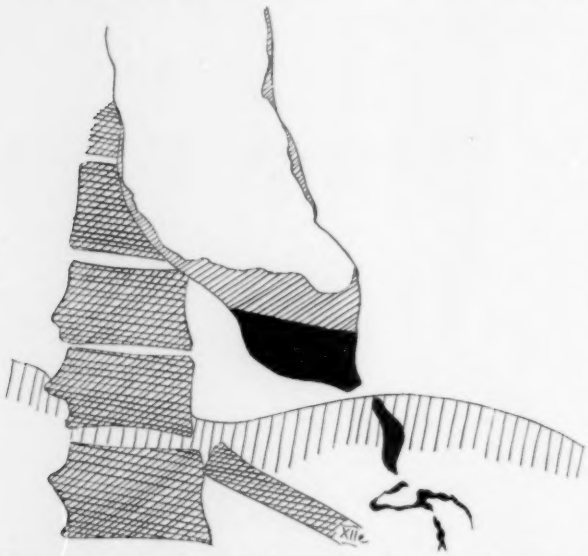

FIG. 19.—Case V. Same as Fig. 18, but taken one-half hour after opaque meal. Oblique plane.

Bard says we must accustom ourselves to the thought that in congenital dilatations of hollow viscera we do not find any mechanical obstacle to explain the dilatation; these organs are simply too wide and too long from the time of birth.

What then is the cause of this remarkable condition? Bard himself puts forward two hypotheses: From birth the walls of these organs are equipped with such weak tissue that the physiological pressure prevailing in all hollow viscera is sufficient to cause them to give way, so that dilatation ensues. Tuffier long ago put forward a similar idea in his "L'infériorité physiologique des tissus," whereby he wished to explain both idiopathic dilatation of the œsophagus and *e.g.*, gastroptosis. Bard's second hypothesis is based on the idea that many hollow viscera, amongst which is the œsophagus, are sometimes from the beginning of their formation too long and wide, a kind of internal giant growth, similar to acromegalia in the extremities. This growth continues throughout life, and as the room for most hollow viscera is limited, it becomes necessary for these organs to bend and thereby there arise secondary sharp kinks and the formation of valves which again help to aggravate the condition by the obstacles to discharge which they form.

If we transfer these views to the œsophagus, and imagine that it is too long and wide from birth, this would not give rise to clinical symptoms before

the secondary bends or valvular formations had developed. As the œsophagus is firmly attached uppermost at the level of the cricoid cartilage and below at the hiatus of the diaphragm, an eventual prolongation or dilatation would cause a deviation to the right side, where the resistance is least. (Cf. the X-ray photograms). The formation of a sharp bend will most easily come about above the hiatus œsophagi, as this rim will not give way to an increasing dilatation, and as the dilatation is most often most pronounced in the lower part.

It would support Bard's views if by chance we could find in a living or dead person a diffuse dilatation of the œsophagus that had not given rise to clinical symptoms. Such cases are known from the table of post-mortem examinations (Faure, Harbitz, Mandl). It is not absolutely certain that they have been entirely without clinical symptoms; perhaps as suffering from some other serious disease, they have not been examined directly for dysphagia; slight symptoms thereof may have been overlooked, and it is too late at the post-mortem examination to obtain supplementary information from the patient. However this may be, even slight symptoms in diffuse dilatation will indicate that it is primary. On the other hand, it would be fatal to Bard's hypothesis, if a number of cases could be shown in which at the initial stages of the disease it was not possible to trace any dilatation of the œsophagus, or only a slight one, but in which by degrees the dilatation steadily increased. Indeed, the more quickly this development proceeded, the more strongly it would argue against Bard.

The demonstration of other congenital abnormalities will also to a certain extent support Bard's hypothesis, especially if these affect other hollow viscera. Lætulle and Meslay (quoted after Gaudet) also found in their patient hydrocephalus and persistent foramen Botali. Helm's case is more convincing, for it must almost be regarded as the much sought after and finally discovered "missing link" in support of the theory that the pathogenesis is the same in megacolon and in idiopathic dilatation of the œsophagus:

A man, forty years of age, from his youth had been obliged to chew his food well, and drink afterwards. By degrees characteristic but not too distressing symptoms of dilatation of the œsophagus developed. On examination the probe is easily passed into the stomach. Röntgen examination showed that he was suffering both from dilatation of the œsophagus and from megacolon. On the Röntgen picture the cæcum and colon ascendens were 13 cms. broad, after which the colon diminished downwards, so that the sigmoid colon and the rectum had normal dimensions. There was a diffuse pear-shaped dilatation in the lower third part of œsophagus, 10 cms. broad; in the X-ray photogram the connection between œsophagus and the stomach was the size of a little finger. If barium water was used instead of Ba. porridge, little dilatation was visible. The peristalsis from the upper normal part of the œsophagus was almost entirely lost over the wall of the dilated part.

The fact that the disease often begins at such an early age, as appears from the table on page 80, is as least an evidence that a congenital predis-

position, whatever its nature, plays a considerable part in the development of the disease.

IV. *Trauma.*—In several records a statement will be found that trauma preceded the clinical symptoms of dilatation of the œsophagus. A fall on the chest or abdomen is given by Exner, Gottstein and Meyer, a bayonet thrust by Heissler, pressure in the epigastrium between a wall and a heavy roller by Fleiner, etc.

In order that trauma may be given etiological importance, it must be required that dysphagy comes at once, at least not after all the symptoms of the trauma itself have quite disappeared. Further it must be possible to trace after the trauma the development of the dilatation of the œsophagus, step by step. If at the first Röntgen examination there is already pronounced dilatation, we can never exclude the possibility of there having existed a previous latent dilatation that has not been clinically manifest before.

FINAL REMARKS UPON THE PATHOGENESIS

That which so far must be regarded as certain in the maze of observations is that this disease most often begins between the age of ten and twenty-five years, that the cardia and the lower part of the œsophagus in at least one-half of all cases do not evince any alteration at operations or post-mortem examinations, and that in a good many other cases inflammatory constrictions have been found at the lower part of the œsophagus or cardia.

If it is insisted that the foundation of the characteristic clinical picture can only conceivably be a common pathogenesis for all cases, then we proceed farthest by starting with the 50 per cent. in which no alterations in the cardia were found; in the other 50 per cent. with stenoses, adhesions, ulcers or cicatrices, these alterations can be explained as secondary. If, on the other hand, these are regarded as primary, it will be impossible to understand how to find the transition to the second group in which no alterations in the cardia are traceable, either clinically or post-mortem. I presume that none will accept Guisez's explanation (Cf. pp. 82 and 86).

Another alternative is the assumption that the pathogenesis is not the same in all cases, but we thereby destroy the unity of the clinical picture. Has the normal cardia found at post-mortem been in the living person the seat of a spasm that has been relaxed by death? Or on the contrary, was it also uncontracted whilst the patient lived? It certainly was so in those cases where the probe at all examinations always passed smoothly into the stomach.

Have the chronic inflammatory alterations found in the lower part of the œsophagus any causal or secondary relationship to the dilatation? Do we find even at the first appearance of the clinical symptoms a markedly dilated œsophagus, or is it more common to be able to trace the successive development of the dilatation from a normal œsophagus?

As long as questions like these cannot be answered quite satisfactorily, I consider it correct to retain the indifferent designation "idiopathic dilata-

tion of the oesophagus," which merely expresses the idea that we are still in doubt as to the cause. In order to approach the subject more closely, it is necessary to collect more observations of a quite reliable character.

In the course of my work on this question it has proved very difficult to obtain the objective facts that would form the foundation of a solution of the problem. This is partly due to the circumstance that by no means all surgeons are minutely acquainted with the normal anatomical and physiological conditions, when for the first time they operate upon the cardia and the lower part

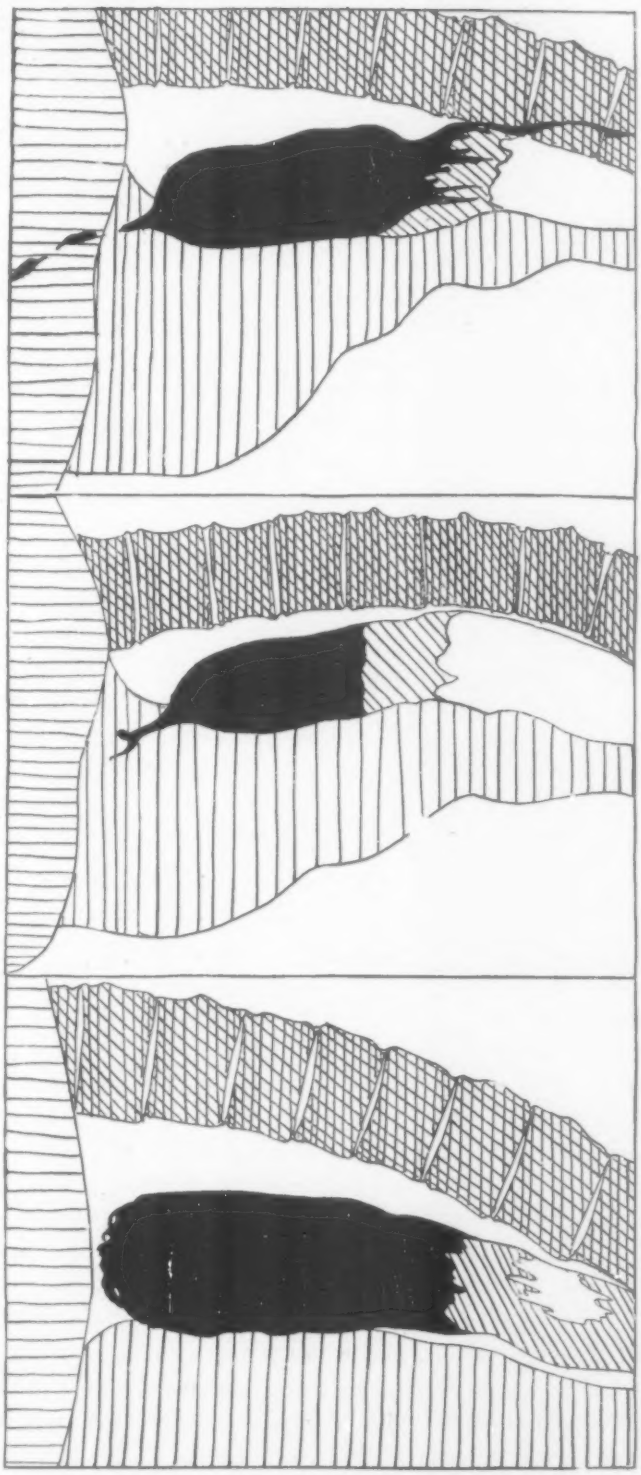

FIG. 20.—A. Carcinoma of the œsophagus. The obstacle is distinctly placed above the diaphragm. Oblique plan. B. A second case of carcinoma of œsophagus. The obstacle distinctly above the diaphragm. C. A third case of carcinoma of the œsophagus. The lower border of the shadow disarticulated in a characteristic manner.

of the œsophagus. This has also the effect that the description of what is found at the operation is not always reliable or convincing; where one writer assumes a certain constriction, there may perhaps, in the opinion of another, prevail quite normal conditions. Indeed, we may see a surgeon sometimes coming into conflict with himself, when the same case is reported on various occasions. This uncertainty is so much the more apparent because it falls to the lot of few surgeons to perform a series of these operations. Most observations involve but single cases.

Often the same may be said about the reports of the post-mortem examinations. Thus 2–8 cms. diameter of the cardia are reported by some as normal, by others as a slight constriction, and by others as a markedly pronounced stricture.

A satisfactory description of the œsophagus at post-mortem examination requires the following demands to be fulfilled:

(1) The œsophagus must be examined *in situ* before and after the removal of lungs and heart.

(2) An examination must be made—still *in situ*—whilst empty and after filling it with fluid, and if possible with the corpse in both a horizontal and a vertical position.

(3) The stomach is opened, and a finger is inserted in the cardia in order that a preliminary idea may be obtained as to whether there is any obstruction or not, and if so, what is the position of the narrow place. Whether there is stenosis or not, special attention is paid to the circumstance whether the tissue is stiff or just as pliable as normally.

(4) The œsophagus is opened just above the diaphragm; its interior is examined carefully, and we especially look to see whether any fold or bend forms an obstacle to discharging. This would perhaps be most apparent if shortly after death the œsophagus is filled with 4 per cent. formalin and is not opened until the following day; but we thereby deprive ourselves of the possibility of determining the consistency of the tissue and its pliability, both of which are of special interest in the case of the cardia.

(5) It is not until these examinations have been made that the œsophagus is taken out in conjunction with the diaphragm and the stomach. If it has previously been opened above the hiatus it is resewn and filled with water in order to see whether the fluid passes through the cardia or not; an experiment which can also be made with thin porridge.

(6) Measurement is made of the volume of the œsophagus, its greatest circumference when filled, and its length.

(7) After opening we measure its breadth at the cardia, at the hiatus and the introitus, and also at several other places, it being always stated how far below introitus or above cardia the measurement is made. The thickness of the wall is measured at the same places. Special attention is paid to the condition of the œsophagus in the hiatus.

(8) The macroscopic condition of the mucous membrane and the muscular system are described: Sections taken at various places, especially cardia and the lower part of the œsophagus, are examined microscopically.

I have considered myself justified in submitting these guiding hints, because in many reports of post-mortem examinations the approximate descriptions have been of no value to me.

TO BE CONTINUED

The subject of treatment with report of cases for the relief of whom œsophagogastrostomia subdiaphragmatica was done will be presented in the February issue of the ANNALS OF SURGERY.

CLINICAL NOTES ON TUBERCULOSIS OF THE KIDNEY

A. RENAL TUBERCULOSIS AND TRAUMA

B. TUBERCULOUS KIDNEY WITH DUPLICATION OF RENAL PELVIS AND URETER

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Professor J. Akerman, Surgeon-in-Chief

It is a generally recognized fact, as is well known, that traumata may produce a locus minoris resistentiæ which offers a grateful soil for bacteria that happen to be circulating in the blood. This is especially marked in certain cases of post-traumatic, septic abscess formations without any external lesion, in which cases the bacteria probably are derived from the tonsils, the intestines, or possibly from some hidden or known focus of infection in the body, *i.e.*, a furuncle or such like. Another fact that is generally recognized is the connection which often is found to exist between traumata and tuberculosis of the bones and joints.

One is hardly ever inclined to associate a case of renal tuberculosis with some trauma or other that is found in the anamnesis. This is quite natural. So often does the medical man come into contact with the usual tendency of the layman to look for external causes of various diseases that à priori he takes a skeptical attitude towards the statement as to the supposed significance of the trauma. Moreover, surely it happens but seldom that any signs of a previous trauma are to be found in a kidney that has been extirpated owing to tuberculosis, whether the kidney is very much destroyed by the tuberculous process or this latter is still at an early stage.

Recently I have had the chance of observing a case of comparatively early renal tuberculosis, in which the removed kidney showed, in addition to the tuberculosis, unmistakable remains of a traumatic lesion of considerable extent. A serious trauma was found, moreover, to exist in the anamnesis. The case ought to merit some interest, and Professor Akerman has kindly left it to me to report it.

Case.—Male, age thirty-two. Case-sheet No. 114, 1924. No known hereditary predisposition for tuberculosis. The patient has always previously been in good health until March 7, 1920, when, while working, he got a heavy stone across the upper part of the abdomen. He felt such severe pain at this place that he had to leave off working. In the evening of the same day the urine was heavily mixed with blood. During the night he had intense desires to micturate and also pain localized to the right side of the abdomen, just below the costal arch. He felt no pain in his back. The pain showed no tendency to radiate. In the days following he had almost perpetual desires to urinate, and at night as much as from ten to twelve times. The urination was not attended with pain. The amount of urine did not increase, but the urine remained bloody. On March 11, 1920, he was admitted to a hospital where he was treated till the beginning of May. During his stay at this hospital, the blood disappeared from the urine, as far as could

be seen with the naked eye, though it could still be detected with the microscope. The abdominal pain which was of a steady, grinding nature never left him. The patient then stayed at home, without doing any work, until June 6, 1920, when he was admitted to a hospital, where he was under treatment till August 6, the same year. The urine contained then albumin and microscopic blood. He was again under hospital care from January 8 to February 8, 1921. The urine did not contain any blood cells, but albumin which, however, soon disappeared. Since the pain persisted, however, the patient was admitted to the Medical Department of the Seraphimer Hospital, April 28, 1921, and was treated there under diagnosis of neurosis until May 30, 1921. The following notes are extracted from the case-record: All of the internal organs are normal in essentials. There is no albumin in the urine, and the sediment contains neither blood cells nor casts, nor bacilli of tuberculosis. May 19, 1921, Röntgen examination of the kidneys: The shadow of the right kidney measures 7, that of the left, 7.5 centimetres in width. Normal positions. No calcareous deposits are visible within kidneys, ureters, or bladder. After his discharge from the Seraphimer Hospital, the patient was working as a lumberman, although he was worried perpetually with pain of the same kind as has been described above, the pain growing at times so severe as to disturb his sleep. The desires to urinate gradually became less frequent, the patient having been entirely rid of these symptoms during the last two months. The urine was now and again macroscopically blood-colored, the last time in October, 1923. The patient was again treated at the Medical Department of the Seraphimer Hospital from January 21 to February 6, 1924. Urine: Heller's test positive. Esbach, ½ 0/00 /. Specific gravity 1.018. The sediment contained red blood cells. No bacilli of tuberculosis. January 24, *Cystoscopic examination:* The mucous membrane of the bladder is normal, except in the immediate neighborhood of the right ureteral orifice where it is swollen and ulcerated. No urine is obtained from the *right* ureter. The urine from the left ureter is quite normal. A Röntgen examination, January 21, of kidneys, ureters, and bladder proved negative. January 28, subcutaneous injection of one milligram of tuberculin. The next day there was a rise in temperature to 38° C. Urine: Heller's test positive. The sediment contained numerous red and white blood cells. The patient was transferred to the Surgical Department, February 6, 1924. *Status:* Good general condition. Heart and lungs normal. Kidneys not palpable or tender. The urine is cloudy and faintly acid. Heller's test positive. Numerous red and fairly numerous white blood cells in the sediment. No bacilli of tuberculosis. February 7, Operation *Olivecrona: Nephrectomy of the right kidney*, which is somewhat enlarged and more adherent than ordinary. The upper pole presents a dark, oval, fluctuating area half the size of a hen's egg, the surface of the kidney being otherwise normal. The renal pelvis and ureter are soft. The latter is ligated with catgut, cauterized, and implanted. A drainage tube is applied to the renal bed. The wound is sutured round the tube.

Macroscopic Examination.—The hardened kidney is 11 centimetres long, 6 centimetres broad, and 3.5 centimetres thick. The main portion of the kidney is superficially lobated, being otherwise quite normal as to shape, color and consistence. The capsule is thin and smooth and can be detached without lacerating the kidney substance. The exterior of the upper pole presents a departure from the normal. Above and medially, there is a rounded cystic bulging, quite the size of a pigeon's egg, which is separated by a deep groove from the surface level of the rest of the kidney. The bulging is of a dark reddish-brown color, its surface is not nodular, and the capsule can only be detached with great difficulty and with considerable laceration of the cortical structure. Immediately below this formation there is a segment-shaped portion; its base, 3.5 centimetres long, is running in a lateral direction and situated at the external border of the kidney; its anterior and posterior points have a medial position at the lower margin of the cyst, above the hilum. The surface of this segment is finely nodular and dotted with alternating gray and red spots, the size of a pin's head, of which the red ones are most numerous and confluent. The capsule covering this area seems normal but offers some slight resistance on being detached. After decapsulation has been completed, the spots and nodules

are seen much more distinct. On section through the kidney (Cf. Fig. 1) the lower and middle portions are found to be quite normal. The markings are sharp; the visible papillary apices are macroscopically normal. The upper part of the kidney, on the other hand, contains two cavities situated close together and separated by a partititon of one half millimetre thickness. The upper, medial cavity is quite the size of a pigeon's egg and filled with limpid fluid. Its interior which is glistening and of a dark bluish-red color with a touch of slate-color is lined with a continuous, shagreened thin layer of connective tissue. Nodules or caseous degeneration are nowhere to be seen. This cavity reaches right out into the upper pole of the kidney, where the wall of the cyst is 2 to 3 millimetres thick. The lower, lateral cavity is quite different in appearance; it is quite the size of a Spanish nut and of a rounded triangular shape, its wall is undergoing caseous degeneration and is seen on section to be thickened so as to form a ridge. The caseous degeneration has an extension of at least two millimetres all round the cavity and continues, while widening here and there so as to form spots, to the convex border within the segment mentioned above. In the wall are seen numerous nodules of tuberculous appearance. The partition between the two cavities runs obliquely outward and upward, is firm and feels tough on being cut. The two surfaces of the partition are different in appearance, each surface presenting the same appearance that characterizes the other walls of the cavity it is bounding. There is nowhere any communication between the two cavities, or between them and the renal pelvis. The main portion of the renal pelvis is pale, smooth and thin, and of normal appearance. Its uppermost portion, near the tuberculous cavity, is somewhat red in color and of a slightly nodular appearance. The ureter is macroscopically normal.

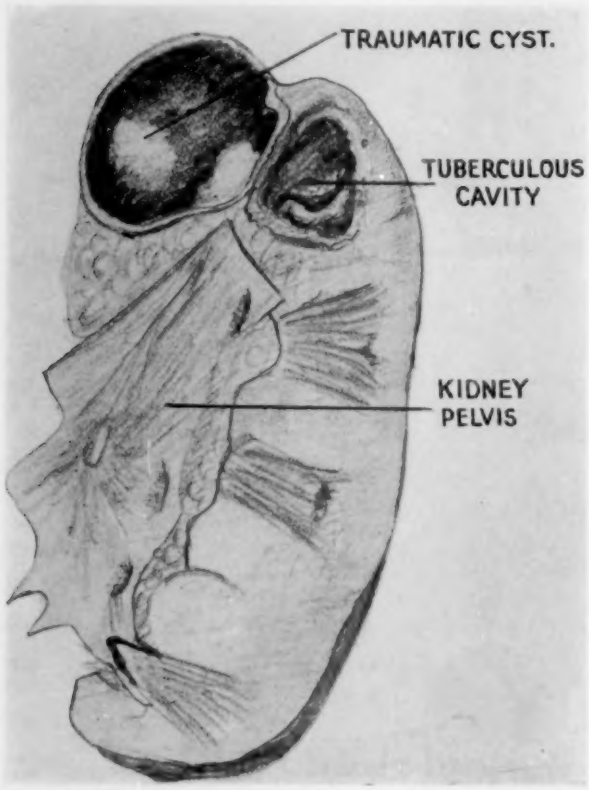

FIG. 1.—Associated renal tuberculosis and trauma; drawn from a specimen removed by operation.

Microscopic Examination (Author).—On examination being made of the cavity undergoing caseous degeneration, its wall was found to contain an enormous number of partly confluent, typical tubercles with epitheloid and giant cells, and toward its lumen was seen a continuous sphacelus of typical caseous appearance. Similar tubercles were found rather far out in the renal parenchyma, as far as the capsule of the kidney and toward the boundary of the smooth, upper cavity, and also up in the remains of renal parenchyma between the lower portions of the cyst and the capsule of the kidney.

Near the lumen, the wall of the cyst showed a continuous fibrous wall of connective tissue with flat, elongated cells arranged in several layers. The cells on the very surface

presented an endotheloid appearance, were smaller, and contained a much greater number of nuclei than the deeper cells. On the outside of this plicated layer there were numerous blood-vessels and also a great deal of extravasated blood, apparently of a recent date. Nowhere in the wall of the cyst were tuberculous changes of any kind to be seen.

No tuberculous changes could be demonstrated in the lower parts of the renal pelvis. In its upper parts were seen some few sub-epithelial tubercles of a recent date. No ulcerations. The epithelium was intact.

Here, thus, we have a case in which a man who had previously been in good health and had not only known tuberculous heredity, develop a severe hæmaturia of comparatively long duration, following a trauma which, judging from circumstances, had been rather serious. Subsequently, frequent desires to urinate as well as renal pain set in. He is received into a hospital, where blood and albumin are found in his urine. The blood gradually disappears and is not observed for quite a long time, but the frequent desires to urinate persist for a couple of years. The pain that we interpreted as being of a renal origin does not disappear, and the patient is treated at a hospital as a neurotic, as all urinary symptoms had disappeared in the meanwhile. Periods of hæmaturia occur, however, now and again. The patient is then admitted into this hospital, but his urine presents nothing abnormal, and a Röntgen examination of his kidneys proves negative. On cystoscopic inspection, however, some small ulcerations are seen around the orifice of the right ureter, from which no urine is obtained. The urine from the left kidney is normal. Following an injection of tuberculin, the patient has a focal reaction which manifests itself by pain in the kidney, pyuria, and fever. An exploratory lumbar incision is made over the right kidney which is assumed to be diseased. The kidney shows certain changes on its surface, partly of tuberculoid and partly of some other appearance, and is removed. On closer anatomo-pathological examination of the kidney, it is found to have in its upper pole a cystic formation which, however, shows no signs of any process in progress or any signs of tuberculosis. In addition to and just below this cyst there is a smaller, tuberculous cavity without any macroscopic communication with the renal pelvis which, however, in its uppermost part is seen to be slightly changed by tuberculosis. In other respects the kidney is sound, both macroscopically and microscopically.

How, then, are we to interpret these two different changes in the kidney? The tuberculosis is indisputable. The cyst, on the other hand, may be a subject for diverging opinions with regard to its genesis. It might be a cystic kidney, a cystic tumor of some kind or other, the remains of a healed tuberculous process, and lastly, the result of a trauma. But a cystic kidney always shows multiple cysts, and no tumor tissue was found in the kidney when examined under the microscope. As to the possibility of a healed tuberculous process being the cause of the cyst, this is beyond the range of our experience, for we have never seen the tuberculosis displaying this tendency to spontaneous healing at one place while in progress elsewhere. In the cases in which a clinical "healing" of the renal tuberculosis has been

observed and which have offered an opportunity of making an anatomo-pathological examination of the involved kidney, it has almost always been a question of a closed tuberculosis, possibly in the form of a caseated kidney ("autonephrectomy"). A tendency to heal is often exhibited by a tuberculous cavity, as soon as it has got into a wide communication with the renal pelvis, which tendency is then manifested by an increased formation of connective tissue in the neighborhood of the still progressing tuberculous necrosis. But a healing such as is seen in this case has probably never been observed before. There remains, thus, only one explanation, namely, a trauma. Moreover, a trauma of a rather violent kind is found in the history of the case, which trauma was followed by a considerable hæmaturia. In my opinion the explanation is probably to be sought in the fact that a hemorrhage occurred in the renal parenchyma at the time of the trauma, the blood having later been resorbed and replaced by a clear fluid, in the same manner as is often observed within other organs, *e.g.*, the brain, where cysts following traumatic hæmatomata are no rare occurrences.

What is, then, the relation between the tuberculosis and this trauma? Here, of course, we are obliged to resort to surmises pure and simple, since the kidney happened to be examined such a long time after the commencement of the respective processes. The possibility, however, is not precluded altogether that a certain relation does really exist between the two. The trauma may possibly have created a locus minoris resistentiæ, at which place an embolus with tubercle bacilli has then settled. In favor of this view argues the fact that the tuberculous process has established itself just close to the wall of the cyst. In that case it is impossible to tell when the tuberculous process has commenced. It may have happened soon after the trauma. We know that the renal tuberculosis is a disease that can progress very slowly and therefore it is by no means precluded that the tuberculous process in this case may be as old as the process set up by the trauma, though it has not advanced further than having barely had time to infect a small portion of the renal pelvis. The tuberculous infection of the kidney may also have taken place at a late stage, when the cyst had already been in existence for quite a long time. Some explanation of the special localization may then possibly be found in the vascular conditions of the connective tissue surrounding the cyst. Lastly, the alternative is, of course, not precluded that circumstances may have played in so that the two processes have developed independent of each other and become intimate coöperators.

In the literature I have not found any similar case described. However, I have considered the case to be of interest at least as a curiosity, if nothing else.

B. TUBERCULOUS KIDNEY WITH DUPLICATION OF THE RENAL PELVIS AND URETER

In the *Acta Chir. Scand.*, vol. iv, 1923, Perman has published an analysis of fourteen cases of tuberculous kidney with duplication of pelvis and ureter which he has found in the literature, as well as a similar case

of his own. Perman emphasizes that such cases are of interest with regard, among other things, to the question of the extension of the tuberculosis within the kidney, particularly Ekehorn's conception of it. Lately, I have had the opportunity of operating upon a case of renal tuberculosis, in which the extirpated kidney presented the said anomaly. Since this case seems to me to be of a certain interest from the same point of view, it is reported below with the kind permission of Professor Akerman.

CASE.—Male, aged eighteen years. Surgical Department II, Case No. 374, 1924. No known heredity of tuberculosis. The patient himself was quite well until three years ago, when he began to suffer from pain and tenderness in his left elbow-joint which ever since has shown limited motion. He has not sought medical advice for it. In April, 1923, a symptomatic swelling of the right wrist-joint gradually developed with tenderness and limited motion. In June, 1923, at some other hospital, he was operated for tuberculosis of the carpal bones, following which he was treated with plaster-of-Paris bandage for six months. In December, 1923, he developed an aching pain in the left side of his back, had more frequent desires to urinate, most marked at night, when he had to get up twice to void his water; and a burning sensation in the urethra on urination. The desires to micturate are not impervious. In March, 1924, the urine was observed to be cloudy, and often faintly blood-stained since the beginning of April, the last few drops being pure blood. Of late, the patient has been feeling weaker. He has not gotten thinner. No cough or night-sweat. Was admitted to the Seraphimer Hospital on April 22, 1924. *Status præsens:* General condition good. The patient is somewhat pale. Temperature afebrile. Heart and lungs are normal. The left kidney is palpable. Prostate and external genitals are normal. Urine cloudy, amphoteric. Specific gravity 1.025. Heller's test positive. The sediment contains plenty of white and red blood cells and some few groups of tubercle bacilli. *Cystoscopic examination*, 25/4 and 28/5: The bladder has a capacity of 100 c.c. The mucuos membrane of the posterior wall of the bladder is considerably flushed, swollen, and particularly coated with some grayish-white fibrin-like mass. Only one ureteral orifice is seen on either side. The right orifice is slit-shaped and of normal appearance; the left one is wide-open, round, with swollen margins. Behind and slightly on the median side of this latter orifice there is a small roundish ulcer, at the edge of which some small nodules are seen, numbering about six or seven. The catheter passes easily into the *right* ureter. The urine obtained from this ureter was clear and acid. Heller's test positive. The sediment contains red blood cells, some few white blood cells and epithelial cells, no tubercle bacilli. The catheter passes without resistance into the *left* ureter. The urine from this side is cloudy and contains small flocculi. Heller's test positive. Red and white blood cells and tubercle bacilli are found in the sediment. Test of the function of the right kidney: following intra-muscular injection of indigocarmine, the urine escaping through the right ureteral catheter is seen to be colored blue within twenty minutes. The function of the left kidney was not tested. June 17 there was a negative Röntgen finding with regard to kidneys, ureters, and bladder. Operation, June 26 (author): *Nephrectomy of the left kidney*. Oblique lumbar incision. Considerable perinephritic adhesions were found all round the kidney except at its upper pole. The fatty capsule of the kidney contained a large amount of fat. Isolated, double ligatures were applied to the vessels. Two accessory vessels in the upper part of the kidney were cut. Two ureters were found, and one of them, namely, the one having the more lateral position, was much thicker than a pencil, rigid, and swelled so as to resemble a string of beads, presented a grayish-white surface, and took its origin from a special lower pelvis which also was thick and hard. The second ureter which had a more median position and ran parallel to its mate, was thin, soft, of a normal grayish-red color, and originated from an upper, apparently healthy pelvis. The kidney was somewhat enlarged; its lower two thirds were both

thicker and harder than a normal kidney, and their surfaces presented some shallow grooves, between which there were some firm and hard and slightly elevated areas of a lighter color than that of a normal kidney. The upper pole of the kidney appeared quite normal as regards shape, color and consistence. The healthy ureter was divided between two ligatures, just below the pelvis. The hard, tuberculous lower ureter was divided by means of Paquelin's cautery after ligation with catgut, at a distance of 8 centimetres from the pelvis. A drainage tube was applied against the ureteral stump, the wound being otherwise closed. Following operation there was activation of the process in the left elbow, attended with pain and tenderness on motion. A Röntgen examination demonstrated that there had been a tuberculous osteitis, now healed, and an arthritis of the elbow-joint. During the convalescence a small abscess formed in the wound. July 2, there was macroscopic hæmaturia. The red and white blood cells did not disappear from the urine during the patient's stay at the hospital, nor did the albumin. The patient was discharged September 19, 1924, the wound being then almost healed. The patient voids his water every third hour in the day-time and once at night. Slight pain in urethral meatus at the end of urination. No pain in the back. He is feeling strong and well. Heller's test of the urine is positive. There is a moderate number of red and white blood cells in the sediment.

Macroscopic examination of the extirpated kidney: The kidney is much longer than normal, 12 centimetres long in a hardened condition, 6 centimetres broad and 5 centimetres thick at the middle of the pathologically changed lower two-thirds. The limit between the upper and the middle third of the kidney is marked on the surface by a sharp ridge, above which the thickness of the kidney rapidly diminishes to 2.5 centimetres. This line of demarcation runs from the hilum, just below the lower margin of the upper renal pelvis, and straight out to the border of the kidney. The lower main portion of the kidney is superficially lobated and of a pale, opaque appearance. The capsule can only be removed with great difficulty and with considerable laceration of the cortical structure. When the kidney has been decapsulated its surface is seen to be very pale and opaque. Nearly everywhere on the surface, especially in the lower part and near the external border, there are to be seen extremely great numbers of grayish-white nodules, from the size of a millet-seed to that of a peppercorn, rising sharply above the surface and having a distinctly tuberculous appearance. They are arranged in groups, some as large as a halfpenny piece, lying close together and equally numerous on the anterior and posterior surfaces of the kidney. On the whole, the upper surface of the main portion of the kidney is smooth and of a more reddish-brown color. The capsule can be very easily removed without any laceration of the cortical substance. Following decapsulation, three areas of a more dark-brown color than the surrounding tissue, two the size of peppercorns and one the size of a farthing, are seen raised above the reddish-brown surface on the posterior aspect of the kidney, near its upper pole. In addition, there is farther down at the back a small area which shows a more diffuse elevation above the surface. On the anterior aspect there are no such irregularities of the surface to be seen.

On making a section through the kidney (Fig. 2) one finds a sharp line of demarcation formed by connective tissue, one-half millimetre thick, running from the hilum, just below the upper renal pelvis, outward and slightly upward to the external border, dividing the kidney into two quite unequal halves, the lower one being large, the upper, smaller. The cut surface below the line of demarcation is very pale and opaque, its normal structure being quite obliterated. There is no marked boundary between the cortical and medullary portions of the kidney, all traces of pyramids are absent and there are no remains left of papillary apices. The section passes through three cavities, each about the size of a hazelnut; one large upper and one smaller lower cavity communicate with the pelvis of the kidney through some short canals, from two to three millimetres wide, and have a fairly firm wall rich in connective tissue; one, situated

just above the middle, seems to have no connection with the pelvis of the kidney, it has caseating walls and is filled with caseous contents. The first two cavities have no contents and their walls seems to be granulating and not at all caseous. The pelvis of the kidney is considerably dilated and presents several bulgings, about the size of a hazelnut, having a wide connection with the main portion of the renal pelvis and probably due to an extensive ulceration of the papillæ. The whole of the surface of the renal pelvis is firm, with abundant connective tissue, and is not caseous as far as can be seen with the naked eye. The pelvis of the kidney is almost entirely filled with a stratified, white-glistening, fragile membrane resembling some cholesteatomatous mass. The thick-walled renal pelvis is continuous downward with a similarly very thick-walled and rigid ureter. The cut surface above the said line of demarcation is quite normal, except at the top of the upper pole. Within the area of the farthing-sized elevation of the surface, which has been mentioned elsewhere, is seen an area, about the size of a brown bean, which reaches right out to the surface. It is grayish-white and necrotic in appearance and surrounded by an irregular, hyperæmic border zone. On special sections being cut through the above-mentioned smaller elevations of the upper surface of the kidney, one finds some sub-capsular, dark-red areas, varying in size from a peppercorn to a pea and simulating infarcta, two of them showing signs of grayish-white necrosis. All of them are extending right out to the surface of the kidney. The renal pelvis and the ureter are of normal appearance in every respect. No nodules, thickenings, or ulcerations are to be seen. The inner surface is smooth and even, the papillæ are seen as fine smooth points plunging into the pelvis. Nowhere in the neighborhood of the renal pelvis are there any foci that can be suspected of being tuberculous.

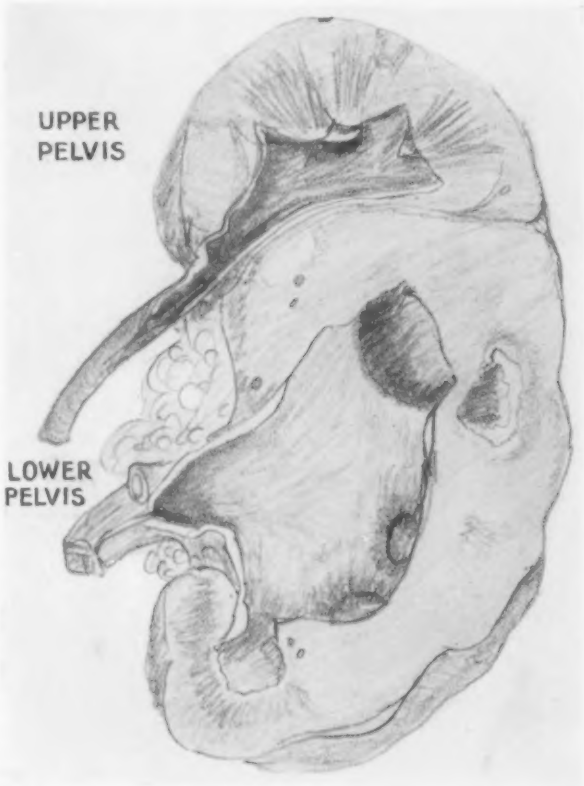

FIG. 2.—Tuberculous kidney with duplication of the renal pelvis and ureter.

Microscopic examination (author) reveals, within the lower segment of the kidney, typical tuberculous areas with tubercles showing epitheloid cells, round cells and giant cells, and caseation. The renal pelvis and the ureter present extensive microscopic changes.

The upper renal pelvis and its ureter show no microscopic changes whatever. In several sections through the renal pelvis the mucous membrane is seen to be intact and without any ulcerations. No sub-epithelial tubercles are to be seen, nor any round-cell infiltrations that might be interpreted as early tubercles.

At examination of the parenchyma of the upper renal pelvis, four typical tubercles with epithelioid cells and giant cells were found within the above-mentioned macro-

scopical foci at the surface of the kidney. Similarly, within a pyramid, between the largest of these foci and the renal pelvis, at a distance of one-half centimetre from the latter, was found a solitary, very recent tubercle with epitheloid and giant cells.

A microscopic examination of the macroscopically quite normal cortex in the upper part of the kidney revealed some sub-capsular, recent, microscopical tubercles containing epithelioid and giant cells surrounded by round cells arranged in palisades. This condition was found to exist at several places where nothing abnormal could be discovered with the naked eye. At other places there were small round-cell infiltrations, in form resembling fresh tubercles.

Here we have, thus, a case of tuberculous kidney with duplication of the renal pelvis and ureter. In the one segment of the kidney, the lower, there is an extensive and comparatively advanced tuberculous process, in the parenchyma as well as in the pelvis and ureter. The other, the upper segment of the kidney, on the other hand, presents only a few small macroscopical, tuberculous foci having a sub-capsular location in the cortex, some microscopical tubercles of the same localization, some microscopical tubercles within a pyramid situated one-half centimetre from the pelvic mucous membrane, but no tuberculous changes of any kind in the mucous membrane itself, or in the ureter, nor could here any ulcerations of the papillæ be demonstrated with the microscope.

Among those cases reviewed by Perman in which nephrectomy was performed, twelve in all, there were two that showed macroscopical changes in both of the pelves and ureters. In the remaining ten cases there were no macroscopical changes either in the parenchyma or in the pelvis or ureter. But three of these cases had microscopical tubercles in the "sound" part of the kidney, and in two of these cases it was stated positively that the tubercles were located in the cortical structure. Information is lacking as to any microscopic examination of the corresponding pelvis and ureter. In Perman's own case there were no microscopical changes to be seen in the sound part of the kidney. In the remaining cases, no microscopic examination had been made.

As pointed out by Perman, the question about the extension of the tuberculosis within the kidney can be elucidated to a certain extent by the anatomopathological study of extirpated tuberculous kidneys presenting the anomaly mentioned above. The theory of Ekehorn purports that the renal tuberculosis has a hæmatogenous, unilocular origin and that its further extension within the kidney usually takes place through an infection of the pelvis (possibly through a tuberculous fistula extending in the direction of the urinary canals) and papillary apices in the neighborhood and through the starting from here of a peripheral tuberculization of the renal parenchyma. According to this theory, then, one would expect to find the tuberculous changes limited to one-half of the kidney and the corresponding pelvis, whereas the other half of the kidney as well as the pelvis and ureter belonging thereto would be free from tuberculosis for a comparatively long time. An infection of the "sound" part of the kidney would take place through a tuberculous process

ascending *via* the ureter. "A direct extension of the tuberculosis to the sound part of the kidney is, of course, possible at a later stage of the disease" (Perman). According to Crabtree, on the other side, one would expect that an extension of the tuberculosis to the "sound" part would take place even at an early stage *via* the sub-capsular lymphatic plexus in the cortical structure of the kidney. In many cases, therefore, one ought to find both microscopical and macroscopical changes, especially in the cortex of the "sound" portion, even though there be no changes in the corresponding renal pelvis and ureter.

On the basis of the cases he has collected, Perman has taken up the question for discussion. In the two cases which presented macroscopical changes in both of the pelves and the ureters, "an ascending infection could not be precluded." From the three cases in which microscopical foci were found in the "sound" part (in two of which cases they were stated to have been located in the cortex) nothing could be inferred in this respect, because no information has been supplied as to the possible existence of microscopical, tuberculous changes in the corresponding renal pelvis and ureter. Nor can any conclusion be drawn from the cases in which no microscopic examination was made and no macroscopical changes were found. From his own case, in which no microscopical changes were observed, Perman infers that the disease can remain localized quite a long time to one of the segments of the kidney. On the whole, Perman is of the opinion that the extension of the tuberculosis within the kidney takes place only very rarely, if ever, along the route described by Crabtree. But he adds that "Ehe diese Fragen sich endgültig entscheiden lassen, sind weitere mikroskopische Untersuchungen nötig."

With a view to this I have made an anatomo-pathological examination of the kidney of my case. It seems to me impossible to interpret the tuberculous infection of the upper segment of the kidney as an infection ascending *via* the ureter and renal pelvis. The macroscopical changes in the periphery of the cortex were few and most of them small, three being the size of peppercorns and one the size of a farthing. The microscopical changes were nearly all of them localized to the most superficial layer of the cortical structure, though some were found inside a pyramid. Several portions of the pelvic and ureteral mucous membrane have been examined, but nowhere I have found any tuberculous changes, not even the very earliest stages in the form of sub-epithelial tubercles. But even if such changes would be found, on serial sections of the pelvic mucous membrane being made, they must, however, be so small and inconsiderable that they could hardly be the origin of the ever so much more advanced changes in the cortex. And the possibility could not be precluded that they might be secondary to the foci in the cortex. In two of the sections, some microscopical tubercles have been found inside a pyramid and perhaps these ought to be interpreted as a halting-place on the way to the renal pelvis. As regards the possibility of a direct extension taking

place from the tuberculosis in the lower segment of the kidney, which is by no means recent to the least affected segment, such a contingency must be dismissed entirely. The tuberculous foci in the upper segment were multiple and some of them were lying at a comparatively long distance from their assumed source. In this case there is hardly any other route left by which the infection may spread to the " sound " part than by the one pointed out by Crabtree, namely, *via* the sub-capsular lymph plexus in the renal cortex. It is impossible, however, to express an opinion with any degree of certainty as to which route is the most common. Many more observations are required for that.

ANEURISM OF THE RENAL ARTERY

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Aneurism of the renal artery is a very rare condition. In the recent paper on this subject by Doctor Conroy (Annals of Surgery, November, 1923) the author was able to assemble only 32 cases, including the observation of his own. It will therefore be of some interest to add two new cases to this small number.

My own observation was as follows:

A man twenty-two years of age, formerly quite healthy, was stabbed on December 1, 1922, with a knife in the left loin. He was brought immediately to the local hospital, where a severe hemorrhage was stopped by tamponading the deep wound. The urine passed by the patient one hour after the accident was mixed with blood. After three weeks the external wound was healed, since five days the urine had showed only traces of blood and the patient left the hospital. A week later there appeared without any known cause a very severe hemorrhage from the bladder, the patient estimated his loss of blood to four litres. The next day the urine was clear again, but the bleeding returned, although not so copious, every third or fourth day. By strongly pressing on the left loin and compressing the penis, the patient could stop the bleeding for a short time. He grew weaker and weaker; he returned to the hospital, where various internal drugs were tried without any effect, so the patient was transferred to the surgical clinic.

On the day of his admission, February 5, 1924, almost one and a half years after he had been wounded, his condition was as follows: Nutrition very poor, high degree of anæmia, red count 1,200,000, white count 10,000, Sahli 60, coagulation time markedly lengthened, lungs and heart normal, pulse rate 108, temperature about 36 Cel. In the left posterior axillary line in the eighth intercostal space there is a retracted scar, 5 cm. long, tender on pressure. In the left kidney-region is palpable a large tumor reaching to the linea alba, stretching under the left costal border, below to the anterior superior iliac spine. The tumor is rather soft, pulsating very distinctly, and a systolic bruit is audible over the whole palpable tumor. The urine is dark, troubled, of alkaline reaction, chlorids normal, many epithelial casts, old red corpuscles, amorphous phosphates and numerous bacteria; cystoscopic examination negative, urine from the right kidney normal, and in normal quantity. On the following day again a copious bleeding from the bladder, pulse much weaker, therefore immediate operation. Ether narcosis, almost transverse incision from the external border of the erector spinæ to the external border of the rectus abdominis. The tumor adhered closely to the kidney, so that it was impossible to separate the one from the other. The anterior part of the tumor presented a thin-walled sac strongly pulsating, the separating from the neighboring tissues, especially from the diaphragm, was difficult and troublesome, the danger of lacerating the walls of the sac was imminent. The anterior 4 or 5 cm. of the aneurismal sac adhered so closely to the walls of the aorta that it was impossible to separate them without rupturing the one or the other. Therefore two curved clamps were laid on the neck of the sac one and a half cm. externally from the wall of the aorta and the whole tumor, aneurism and the kidney was cut away. A thin but strong stream of blood gushed between the clamps, their ends did not meet exactly, but the hemorrhage was easily stopped by a third clamp. The walls of the sac were now sewn together along the clamps with a mattress suture and the clamps removed, there was no bleeding. A second row of

stitches was added nearer the aorta and the suture line covered with adjoining connective tissue by a sort of Lembert suture. A rubber tube was introduced to the bottom of the wound.

The removed tumor is a sac of the size of a big orange, filled loosely with fresh, partly with older clots, its walls are thin, on microscopical examination were found well developed elastic, no muscular fibres. The kidney lay on the external wall of the sac, in its upper end there is a hole 2.5 cm. in diameter, communicating with the renal pelvis. (Fig. 1.)

Subsequent course uneventful; in the first twenty-four hours the patient passed 240 cm. blood-tinged urine; on the following day urine is clear, 800 cm.; on the third day, 1800 cm. The patient leaves the clinic April 14, quite healed.

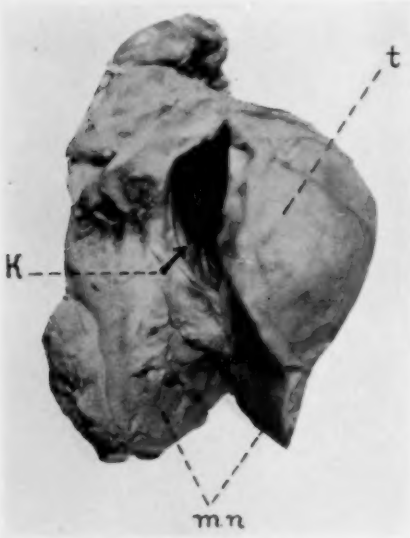

FIG. 1.—Aneurism of renal artery. m n, Kidney tissue. t, Aneurismal sac. K, Cut showing the communication between the sac and the pelvis of the kidney.

On discussion of the above case at the last meeting of Polish surgeons in Lwow, Doctor Sokolowski related the case of a woman, some fifty years of age, who died under symptoms of internal hemorrhage within some hours, before anything could be done to save her life. At post-mortem examination there was found a very extensive hæmatoma in the left loin and as its source a ruptured aneurism, size of a walnut, of the renal artery.

Including the above two cases we have 34 cases of renal aneurism known in the literature. Sixteen of them were true spontaneous aneurisms developed on sclerosis or fatty degeneration of the walls of the artery; the average age of these patients was fifty-six years. In many of them the aneurism has been found only at the post-mortem examination (cases of Leudet, Danner, Oestreich and Sokolowski); in the case of Key and Akerlund an operation was done under the diagnosis of "stone in the kidney." In the 18 traumatic aneurisms the age was of course of no influence, the trauma was fifteen times subcutaneous: fall from horseback, from staircase or a ladder, a heavy stroke in the loin and the like; only three times there was an open wound of the kidney, in the case of Kaunitz a shot, in the case of Orth and mine a stab wound. It is evident that open wounds of the kidney are very seldom followed by renal aneurism. Bier says, that among many traumatic aneurisms seen in the last war he has never met an aneurism of the renal artery.

Our case is remarkable still on another account; the structure of the wall seems to point that there was a true aneurism of the renal artery, of unknown cause, which gave no symptoms until the stab established a communication between its sac and the renal pelvis. The whole renal artery was dilated, the sac stretching closely to the aortic wall.

The signs of a renal aneurism are not sufficiently characteristic, the diagnosis was certain only in five cases, our case would be the sixth, in which a right diagnosis was made before the operation, but it must be said, that in our case all the classical symptoms of an aneurism were present, there was a history of trauma with following hæmaturia, a palpable tumor in the kidney region, distinct pulsation and audible thrill. The course of the disease may be different, some times it is very rapid, death following soon (in the cases of Rouppé and Sokolowski only a few hours) after the appearance of the first symptoms, usually the attacks of pain and hæmaturia last some days, then disappear for some days, even weeks only to return more severe, they exhaust the vital forces of the patient and bring his death after months, even years; the average duration of the disease, tells Conroy, is 284 days.

Prognosis is very serious, all the cases treated conservatively died; from the operated, two died, seven were healed (cases of Hochenegg, Hahn, Keen, Skillern, Key-Akerlund, Orth and our own).

The operation is almost always very serious and has to overcome many difficulties; the separation of the aneurism of the kidney was in all cases, except in the case of Orth, impossible, and the kidney ought to be removed. The bursting of the sac caused a mortal hemorrhage in the case of Morris and the patient of Skillern could be saved only by clamping the torn wall of the sac and leaving the clamps in the wound; they were taken off on the fifth day, the hemorrhage did not return. In the case of Orth it was possible, after opening the sac, to find the hole in the renal artery and close it with a suture, the kidney was left *in situ*, and its function was normal.

Because of this danger of hemorrhage in difficult cases, Morris advises to open the peritoneal cavity, separate the renal artery, ligate this vessel at its branching from the aorta and then finish the extirpation of the aneurism and the kidney. In my case even this would have been impossible, the neck of the sac being too close to the aortic wall. The proceeding described above, a sort of lateral suture of the aorta, proved satisfactory.

As one can never be sure, whether the kidney can be saved, in most cases it must be removed, it is of prime importance to make sure that the other kidney be sufficiently healthy.

LATENT JAUNDICE AS A SYMPTOM OF BILIARY COLIC

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In an article published two years ago,[1] I pointed out the clinical significance of bilirubin determinations in the blood serum. Since that time, the number of cases observed has increased, but the points of clinical interest have not changed. A short summary of this previous paper is the following:

(1) An increase of serum bilirubin was found after biliary colics, even in cases where scleral jaundice or bile-pigment in the urine was absent. Colics of other origin (appendix, stomach, intestines, kidney and ureter) gave negative results.

(2) Old hemorrhages could be demonstrated in the cerebrospinal fluid and in joint exudates with the help of the Van den Bergh test for bilirubin.

(3) A difference between pernicious anæmia and secondary anæmias (especially occult carcinoma) could be found; in the latter the amount of bilirubin in the blood being normal or subnormal in contrast with pernicious anæmia. Aplastic anæmia showed no increase in bilirubin.

(4) The increase of bilirubin in a certain group of cases was a sensitive index of increased hæmolysis and as such gave the indication for splenectomy. If in cases of pernicious anæmia, beside an enlarged spleen, increased hæmolysis could be found, splenectomy was advised.

It is with the first group of cases, that the present paper is concerned, namely biliary colics. About thirty per cent. of all gall-stone cases and seventy-five per cent. of common duct-stone cases have jaundice in their history,[2] so that a manifest jaundice is by no means a frequent symptom in cholelithiasis. Friedman and Strauss,[3] using the Fouchet test, demonstrated just recently a hyper-bilirubinæmia in cases of cholecystitis during the attack, in ninety-three per cent. of all cases. I used the original Van den Bergh method in all cases[4] and can report now of fifteen biliary colics examined during or shortly after the attack. Only quite typical colics have been selected and the presence of gall-stones has been verified each time by operation.

Blood was taken every five hours after the attack for two days. In every case an increase in the amount of bilirubin was found, extending from 1.5 mg. to 8 mg. in 100 c.c. of blood, and none of these cases developed visible jaundice with the exception of one. This patient, after having shown a bilirubin of 8 mg. per cent. on the next day following the attack, became jaundiced on the fourth day, and an impacted stone at the papilla of Vater was found at operation.

The threshold of elimination for bilirubin is supposed to be at 2 mg. in 100 c.c. of blood. Yet it seems as if not only the percentage but the duration of hyperbilirubinæmia would have an effect on the appearance of jaundice.

In a case reported in my previous article, jaundice persisted for eight months with a bilirubin of 8 mg. per cent. just before operation. After choledochotomy, the serum bilirubin decreased rapidly and was found to be 1.4 mg. per cent. on the fourteenth day. Only at this level—lower than 2 mg.—did the bilirubin disappear from the urine. On the other hand, our figures after biliary colic were always higher than 2 mg. per cent. and yet no scleral icterus, no positive Gmelin test could be found. In a short, temporary obstruction like a gall-stone colic, the serum is quite yellow without the slightest pigment

FIG. 1.—Biblirubin curves of the blood serum after biliary colic. Straight line: No atropine was given. Average curve of 10 cases. Dotted line: Atropine was given at the 18th hour. Average curve of 4 cases. Interrupted line: Atropine given at the beginning of the colic. One case.

excretion. For the appearance of scleral icterus and bilirubin in the urine, besides a hyperbilirubinæmia, a certain duration of this condition seems to be necessary. This short bilirubinæmia following gall-stone colic may be due to a sudden increase of tension in the biliary ducts. Westphal [5] examined patients during the gall-stone colic under the fluoroscope and found in twenty-one cases a marked increase of gastric motility from a hyperperistalsis to total gastro-spasms. Pain of greatest intensity was felt about two finger-widths to the right of the pylorus, in the region of the common duct sphincter. Spasms in ileum and colon were also present. The same author saw on cats a contraction of the whole common duct sphincter with marked inhibition of bile flow after strong electric stimulation of the cervical vagus. The same effect could be obtained with a pharmacological stimulation of the vagus with pilocarpine.

If the increased bilirubinæmia is due to increased bile-tension and this latter due to muscle spasm, the injection of atropine ought to stop the pain, diminish bile-tension and decrease bilirubinæmia. No one could measure bile tension in man during a colic, but by the determination of serum-bilirubin, the effect of atropine might be objectively demonstrated. That an intravenous injection of atropine stops the pain and relaxes the gastro-spasm during the attack, has already been demonstrated by Westphal (*l. c.*). In our last five cases, I have tried to demonstrate the effect of atropine on the bilirubin curve. It need not be emphasized, that if the increasing bilirubinæmia is due to something more than a pure muscle cramp (organic obstruction), this drug cannot have a marked effect on the jaundice curve. This was the case in the patient with a common duct stone. In the other four cases the intravenous administration of 0.5 mg. atropine, on the bilirubin curve was evident. In three of these morphine had already been given, but this drug does not have a sedative effect on muscle spasms, according to radiological experiences with gastro-intestinal spasms; on the contrary, it may cause gastric antiperistalsis. In one case, the colic appearing during observation in the hospital, atropine could be given right at the start, followed by relief from pain in about five minutes. The abdomen completely relaxed, a swollen liver and distended gall-bladder could be palpated without tenderness.

The duration of bilirubinæmia was found to be one to three days. In cases where atropine was given, the curve dropped suddenly and did not rise again except in a case of organic obstruction. A chart (Fig. 1) illustrates the average bilirubin curve after biliary colic in its relationship to a curve that was interrupted by atropine at the eighteenth hour and another curve, where atropine has been given at the beginning. The effect of this drug on the level and duration of hyperbilirubinæmia shows up distinctly and supports the great importance of the muscular mechanism of bile ducts in jaundice. Atropine administered intravenously caused no ill effects except a dryness of the throat and marked vasodilatation of the face for a very short time. There was no vomiting and the pulse rate showed an average increase of ten to twenty for the first half hour.

SUMMARY

(1) In fifteen cases of biliary colic an increased amount of bilirubin was found in the blood without the presence of manifest jaundice.

(2) This hyperbilirubinæmia could be lowered in four instances out of five by the intravenous injection of 0.5 mg. of atropine. This fact might be explained by the relaxation of the muscles that regulate bile flow.

These few cases do not permit any definite conclusions whatever and are just presented as a plea for further investigation.

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SOME FRACTURE CALAMITIES AND THEIR MANAGEMENT

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During thirty years general hospital work I have had my share of badly displaced and malunited fractures, some due to primary isolation by long distance from surgical aid, some to lack of decision to administer an anæsthetic and properly correct the deformity, some to want of an X-ray photo, and far too many to the foolish immediate hiding of the acutely swollen part in a plaster case. To these must be added defective splinting, that calamitous obsession early movement, and the temporary partial removal of splints in the delusion of speeding up cure by massage before the callus has had time to set.

Rightly or wrongly I visualize the consolidation of callus as somewhat comparable to that of the cement of the artisan and consequently view the effect of any immature movement from a similar angle, an opinion which is intensified by personal experience in which the daily loosening of splints for the application of skilled massage has notably increased the incidence of non-union and in some instances has induced a subsequent mild deformity which remained, to say the least, a cosmetic defect to the owner and a reflective sting to myself.

I warn those who advocate ambulatory treatment in fractures to beware of the possibility of refracture of the limb, when following active movement pain suddenly develops in the line of a fracture which may appear firmly united, and the necessity of promptly immobilizing such a limb. At this moment (July, 1924) I happen to have under treatment an excellent example of what in my experience is not a rare setback:

An apparently robust young man who had a simple fracture through the middle third of the femur was treated by me in hospital for sixty days with absolute rest in splint and extension. Sound union seemed to have taken place. To be on the safe side, the limb was kept at rest on pillows between sandbags for a further fourteen days, during which daily massage was applied. The condition then appeared normal; he was taken to the X-ray room to have a photo taken; while this was being done he felt for the first time a pain at the seat of fracture. After his return to bed, the pain subsided, but later on the same day, when attempting to flex the limb over the side of his bed, he again felt an acute pain and on examination, a complete re-fracture was found to have occurred. The long Liston splint with extension was immediately re-applied and the limb retained in the same for a further ninety days. Sound union eventually took place. Only one centimetre of shortening remained, as verified by three independent measurements. There was free movement in the knee-joint, N. B. after 150 days in absolute rest in splint. He left hospital walking without stick or limp twenty-one days later, able to flex knee through a full right angle.

Gunshot Joint-fractures.—From the operative angle my experience with fracture deformities of the hip and shoulder, with the two following exceptions, has been limited to a few osteotomies with partial benefit. A Welsh boy, age fourteen, when fiddling

with a loaded Winchester received a bullet wound of his right hip which comminuted a segment of acetabulum and the corresponding portion of the head of the femur. Having exposed the joint, I removed some splinters, but as the bullet had ensconced itself in the depth of the socket I had partially (without rupture of ligamentum teres) to dislocate the head before I could find it. The bullet was then removed along with all visible debris, and the head of the bone re-adjusted. The wound healed aseptically, and the boy was discharged from hospital three months later without deformity and with some progressive active movement in the articulation. A year later his father wrote "The lad can now ride all day on horse back."

A gunshot fracture of the head of the humerus was met with in the person of a young engineer, the lesion having been caused by accident with a revolver. The bullet entered just anterior to the deltoid muscle leaving a small external wound which rapidly cicatrized. The arm could not be abducted from its fixed position at the side of the chest. An X-ray photo showed the bullet lodged in the head of the humerus. In this case a vertical incision was made through the posterior portion of the deltoid, the joint was opened, and as the bullet could not be then located, the head of the bone was dislocated outwards. A comminuted fracture of its apex was then readily seen with some small chips of cartilage loose in the joint cavity. After scraping through the fractured surface of the head, the bullet embedded in cancellous tissue was easily removed. After careful toilet, the dislocation was reduced and the outer wound united by silkworm gut. Aseptic union ensued, active movement was begun on the fourteenth day, full movement followed, and four years later he underwent an active physical trial in The Great War through which he passed unscathed.

The most weird specimens were some atrocious deformities attending old neglected fractures involving the wrist and ankle joints which required for correction most radical procedures of *brisement forcé,* with, in some cases, arthrotomy and osteotomy. In three particularly desperate cases involving the ankle joint, although it was necessary to open freely the joint, the three eventually walked out with foot in normal alignment and with progressive active movement in the joint.

The most insuperable cases to tackle were intra-articular fractures of the elbow and knee joints in which callus formation—often stimulated by what I have termed the "damnation movement" of joints—had run riot with erection of bony buttresses which nothing less than excision of the joint could shift.

I have had a varied assortment of badly set fractures in long bones. Generally fortified by the reflection that matters could not be made much worse, I have for many years made it a rule to have a try in every case occurring in a healthy person under fifty years of age.

Taken on the whole, I think that I am justified in stating that the ultimate results of my operative intervention in fracture deformities have far exceeded my expectations, and strange to relate the least hopeful often excelled anticipation.

Cognizance of the responsibility attending recommendation of a bold policy makes it incumbent to enjoin—do not rush to operate; study the soil and lesion when practicable for a week or two, during which have blood-polluting teeth and tonsils removed.

At the operation make the primary incision of such dimension as may

insure free use of the eyesight. Do not apply a tourniquet, except in serious septic conditions, but instantly seize and ligate every bleeding point. With hammer and chisel break up completely the vicious union. With strong elevators lever the ends of bone out of their abnormal position. Do not calculate the anatomical relations too minutely, but spare main vessels, trunk nerves, tendons and every possible scrap of periosteum in the endeavor to have a sufficiency of this membrane for subsequent reposition over the line of fracture on which the result of the operation may largely depend. Extrude the ends of bone through the wound in order to make certain that they are thoroughly liberated from their adventitious connections, and all interposing tissue removed from their surfaces. Clip away all inconvenient knobs and barnacles, but if possible do not remove a loose fragment of bone, particularly if it has any periosteum intact as at the end of operation it may prove a very useful little graft or splint for reinforcement of the line of approximation of the fragments, which can often be secured *in situ* by strong catgut ligatures which can be firmly applied by making with saw a few slots in opposing bone fragments for their reception.

In the final adjustment of the fragments, whenever feasible, I am partial to a dovetail impaction of the fragments. As to mechanical aids, I prefer a Lane plate, whenever applicable, making when necessary, with osteotome and hammer a level bed for same above and below.

For cutting bone grafts as well as for most general operations, I employ what I consider the best of surgical dynamos, a pair of hands, aided in this particular instance by an osteotome and a hammer.

The following method of procedure I find rapid and effective:

(1) When the site for the graft has been prepared, take the dimensions of the graft required by cutting a piece of thin lead foil to its exact size and shape.

(2) Then expose the periosteum through a corresponding area over, *e.g.*, the anterior surface of a tibia.

(3) Guided by the application of the mould to the part, with scalpel, make two transverse incisions through the periosteum, one at the upper and the other at the lower border of the mould, sufficient for the application of an osteotome whose width at least *should be double* that of the graft required. The bone is then divided above and below transversely into the medullary canal.

(4) The mould still retained in position, *i.e.*, over the bone central between the limits of the two transverse osteal sections, the periosteum is then incised along the lateral margins of the mould joining the transverse lines.

(5) Commencing at one end of a longitudinal line with osteotome the bone is lightly grooved, in due osteal grain, from one transverse section to the other by gentle taps with a hammer. A narrow furrow is next similarly outlined on the other side.

The reason for employing an osteotome much broader than the graft required will now be obvious in that the two longitudinal grooves begin and

end distinctly within the compass of the transverse sections. Attention to this detail insures a direct line in proper plane and excludes any possibility of splitting the bone above or below the limits defined for removal of graft when the osteotome is made to complete the bilateral osteal division into the medulla.

(6) The graft, with its periosteum intact, is then levered out and directly applied where required. This wound is at once closed by through-and-through silkworm gut sutures, each of which is made in transit to embrace any periosteum available. The tibial wound is then sutured.

Although unfortunately many of the worst instances of fracture displacement are already septic when admitted to hospital, which imposes an enormous handicap on their proper treatment, yet I do not know of any branch of surgical practice which affords such fascinating work and such a test of surgery, not to mention such obvious demonstration of what nature can do if given a decent chance by free dependent drainage, removal of dead material and foreign bodies, absolute rest, and liberal antiseptic irrigation. What I have found an ideal antiseptic combination for a desperate infected wound is warm peroxide of hydrogen lotion (1 in 17) followed instantly with warm carbolic (liquid) solution (1 in 70), backed up by a hot corrosive sublimate fomentation (1 in 3000), wrung dry without any nocuous impermeable covering. While mercurial (in weak solution) dressing is the most reliable and non-irritating one for the aseptic preservation of the surrounding skin, it is unsuitable as a wash for the interior of a wound owing to its quenchability. The opinion thus expressed has been derived from over one hundred thousand irrigations and fomentations with said chemicals and I have yet to see an instance of absorption or of irritation of the skin follow their employment. It is my creed that any antiseptic which tends in any degree to cause irritation of the cells of the skin is, *ipso facto*, an unsuitable one for disinfection of the interior of a wound. This is what I have for years endeavored to inculcate as *the skin index* in the antiseptic treatment of infected wounds, also remembering that the above-mentioned formula must only be used in a strength which will not mortify the friend in the effort to expel the foe. The above combination conforms to this requirement, and, the heat included, stimulates the necessary migration of leucocytes to the part.

When infection has been controlled the irrigations and fomentations are accordingly reduced. A dressing for a recent septic cavity now highly prized in my service is the tucking of one end of the hot fomentation lint gently into the depth of the cavity after the morning irrigation with peroxide carbolic lotion and leaving same in position until the following day. Prior to the removal from the operating table, bone cavities are stuffed with gauze wrung out in hot, 1–3000, mercurial lotion. This packing is left *in situ* for forty-eight hours.

I find that so long as the arterial supply remains intact and, in unison with the above antisepsis, gravity drainage is insured by large wisps of silkworm gut (which do not become foci of sepsis nor cause necrosis of their

tracks through tunnel wounds and which always drain), by the twentieth day most mutilated limbs will show a hopeful display of brilliant vermilion granulations (robust cells) which to me is the most entrancing scene in Nature. All septic fractures are well fed, and, winter and summer, are permanently retained in an outdoor sunny balcony.

Apart from the acute conditions, I do not know of anything which calls for more deliberation than when to intervene in cases of grave bone injury in which purulent discharge persists after primary operation and weeks or months later the probe reveals partial necrosis. My experience dictates, if the general condition remains normal, not to rush matters with hammer and chisel, but to wait until Nature has demarcated, if not detached, the moribund segment; then removal is simplified, and probable injury to the healthy portion obviated.

At the moment of writing this note I have a good illustration under my care. A young man had the lower third of his femur shattered by a bomb explosion. Immediate operation was performed. Some fragments beyond hope of utility were removed and free drainage provided. Toxic symptoms gradually disappeared, but a purulent discharge continued; two months later the probe revealed some dead bone although union had taken place. Fearing refracture, I deferred operation and one month afterwards, the probe indicating detachment, I opened up the wound and without any force with forceps removed one large sequestrum and three small ones from a large cavity lined with granulations in a united femur.

The following case of ankylosis of the knee, sequel to a fracture of the patella, is worth recording. It was one of the first instances in which I mustered up courage to apply general surgical principles to a deformity following fracture in a knee-joint:

P. S. age thirty, sailor, was admitted to hospital June 2, 1896, suffering from "stiffness" and "swelling" of left knee-joint.

Previous History.—While working on deck, February 3, 1895, he was knocked down by a sea. The left knee became instantly swollen and tender. At the end of the voyage, after a month's rest in his bunk, he was taken to a hospital in Hamburg. After six months he was discharged with an elastic bandage but was unable to resume work for another two months owing to constant pain, tenderness and swelling, and from that time until his admission to the British Hospital in Buenos Aires, he could not flex the leg beyond a right angle. On March 15, 1896, while crossing from ship to wharf, the plank broke and he fell into the water, the left knee striking the curbstone as he fell. Immediately on being picked up his mates "recognized that the knee cap was split in two." He was taken to the nearest hospital, the limb was placed in a box splint for seventeen days, after which three consecutive plaster cases were applied and thus the joint was kept immobile until he came to Buenos Aires on June 2. On examination, the joint was found much swollen, with thickened synovial membrane bulging at each side of the patellar ligament. The bursa patellæ was considerably distended, active movement in the joint absent, and any attempt at passive motion caused severe pain. On palpation, a malunited vertical fracture of the patella could be distinctly felt. There was increase in local heat, but the body temperature was normal. These signs, along with the history, made the diagnosis certain that dense adhesions had formed which prevented flexion, probably associated with organized blood clot, and that enlargement of the bursa was due to effused blood. On June 4 a large lateral incision was made into the joint; no blood or serum presented, but when the right index finger was inserted the patella was found

bound down to the femur by a number of dense broad organized bands. A futile attempt was made to rupture these adhesions with a finger, then a strong scissors was introduced and, seriatim, six dense masses of fibrous tissue were divided with a grating noise suggestive of division of dry gristle.

A considerable amount of hemorrhage ensued, which did not yield to temporary packing, so it was thought advisable to irrigate with warm turpentine lotion in spite of which the bleeding continued, and nothing remained but to plug the whole cavity firmly with iodoform gauze. Three waiting sutures were inserted through the wound, a splint applied and dressing firmly bandaged over the knee. The pre-patellar bursitis had been dealt with by a hurried incision, about one ounce of blood clot was evacuated, and a gauze drain introduced.

The external dressing was changed on the second day, it was saturated with blood. As the pack in the joint was in a similar condition, it was removed, the turpentine irrigation repeated, and a fresh plug inserted. On the sixth day the sanguineous discharge had ceased, everything dry. On the ninth day the external wound was closed by the waiting sutures. On the fifteenth day the splint was removed. The wound had healed and the patient was exhorted to commence active movement of the joint. On the following day he was allowed out of bed. He could flex the knee to a right angle; two days later he walked across the ward without a stick; by the thirtieth day he was able to run and flex the leg, almost making his heel touch the nates, and on the fortieth day, he walked out of hospital without a limp, with movement of his knee-joint normal in range. A month later he returned to work and sent word that "the knee was tip top." I think that I may add that I received my baptism of joint fright in this case, fortunately followed by a reaction which hardened my heart as far as knee-joint surgery is concerned.

Myeloid Sarcoma Supervening at Fracture Site.—P. W. age twenty-three, was admitted to hospital on March 11, 1923, suffering from a simple fracture of the lower third of the femur incurred at football on the same date. There was marked backward displacement of the lower fragment with two and a half inches of shortening. The limb was placed in a Liston splint, with extension which, in a few days, carried a fourteen pound weight. A special pad, on a short back splint, was applied posteriorly. On the third day, the fragments felt in normal alignment, and there was then only one inch of shortening. An X-ray photo was taken on the fifteenth day and showed the fragments in normal apposition.

The splint and extension were removed on the forty-eighth day and, as good union without any deformity seemed to have taken place, the patient was told gradually to commence active movement of the knee-joint. During the ensuing fortnight the limb was maintained at rest on a long pillow between sand bags, except morning and evening, when he practised the above movements under the supervision of a nurse. Everything went on well and he was discharged on crutches on the eighty-third day—gradually increasing the amount of weight put on the foot. A month later he returned (on crutches) to show himself complaining of inability to bear his weight on the leg. Examination did not reveal anything to account for this inability. The union appeared to have consolidated, with one inch of shortening of the limb.

September 15 he again returned with a similar tale, and on examination non-union was apparent with the upper fragment visibly and palpably displaced upwards and outwards. At the end of this fragment there was visible a deep sulcus, at the bottom of which the lower fragment could be felt displaced backwards if anything to a more pronounced degree than when first admitted to the hospital. The man stoutly denied any extra movement, had not fallen, and had not felt a fresh break. He stated "since I was here a month ago I have felt it more painful, and have noticed a lump which had not been there before." Now there was a shortening of three inches. Two days later, under open ether, a long incision was made in the lower antero-external part of the thigh directly over the bulging upper fragment. The projecting end of bone was readily extruded through the wound. It took some twenty minutes to separate the

adhesions which had glued the lower fragment into its posterior bed. Finally it was released and similarly protruded through the wound. A careful examination was made of each surface but there was not a sign of anything like disease in either. The end of the upper fragment, looking quite healthy, was dentated and contained one large spicule which prevented juxtaposition, this was sawed through in a reverse oblique fashion so as to form a posterior shelf on which the upper end of the lower fragment could repose without danger of slipping backwards. The lower fractured surface looked quite normal without any contiguous thickening, etc., of bone. When the ends were approximated it was found that good apposition had been obtained by the shelf plan. For insurance reasons a superficial plane above and below was made by a few touches of an osteotome and hammer for the comfortable reception of a four screw Lane plate. The external wound, including periosteum, was united, as usual, by interrupted through and through double silkworm gut sutures. To avoid chances the patient was placed in a Liston frame with an extension carrying fourteen pounds. He was placed in the outdoor balcony, and given full diet, stout, cod liver oil and malt extract and hypophosphites. A blood examination was made on two occasions with negative result. On a third eosinophilic reaction was reported. Hydatid and worms were sought for in vain. The wound healed up normally, but on the forty-sixth day, for the first time, some sanguineous liquid was seen to exude from one angle. As this slight discharge continued, it was thought prudent to remove the plate which might be the cause of same. This was effected by opening up part of the cicatrix. We were gratified to find the bone ends in normal position, and with apparently happy union taking place, the only abnormal thing felt or seen was about one ounce of semi-purulent serum nigh the plate. The screw holes in the bone looked quite aseptic and healthy. As this fluid was present it was thought advisable to leave the wound open and lightly pack it with iodoform gauze.

January 25, before leaving on vacation, I found the wound looking in excellent condition, gradually contracting, and lined with bright vermilion granulations, all trace of former discharge had vanished.

March 21, on returning to duty, I found that a tumefaction had developed on one side of the wound which, by the way, had not shown any tendency to healing during the preceding four weeks. The granulations had changed their color to an unwholesome purple tint. The inner border of the wound appeared swollen, and on posterior pressure a quantity of dark grumous matter with some débris welled up to the surface. Some of this was gathered and sent to the pathologist for examination, with request to look out for sarcoma. Report negative, excepting blood and fibrous tissue cells.

April 7. As this discharge daily increased in quantity ether was administered, I opened up the wound and found that the lower fragment had apparently vanished along with a considerable segment of the upper one. A large cavity had formed, occupied by blood clot, and myriads of bits of bone, suggestive of the work of rats for months previous. Handfuls of this material were evacuated, and as bleeding was brisk the cavity was plugged with rolls of gauze. Some days later a severe hemorrhage took place requiring much packing to control. During the following week dark blood saturated each daily dressing and the wound gradually assumed a brawny appearance with some infiltration extending upwards into the thigh. The temperature had been normal from the beginning. After a consultation with my distinguished friend, Doctor Chutro, the wound was again explored (under ether) with the result that further destruction of the upper fragment seemed to have taken place and the enormous cavity now existing was occupied with the above described material. Half the femur seemed to have gone, and the attempt to empty the cavity of its content induced fresh hemorrhage. I had by this time no doubt that the suspicion whispered on March 21 had become a sad reality. I sent for the boy's parents and recommended immediate amputation through the hip-joint. They asked permission to remove him to another hospital which of course was granted.

June 10, I received a note from the surgeon in charge of the case, informing me that

on that date the limb had been removed by disarticulation at the hip, and that subsequent examination of the part revealed "a large osseous cyst whose walls were degenerated by a malignant fungus myeloid in type." In thirty odd years of hospital experience this is the only instance in which I have met with a malignant growth developing in the seat of a recent fracture.

FIG. 1.—Fracture-dislocation of ankle.

Fracture Luxation of Ankle.—Mrs. D. age forty-six, was admitted to hospital February 18, 1914 with the condition shown in Fig. 1. On March 21, 1913, the lady fell and "broke her ankle." She was at once attended by a surgeon who "set the fracture and bound it up." At the end of a fortnight "he broke it again and reset it" and then "encased the whole thing in plaster-of-Paris which he removed after six weeks when an attack of erysipelas had developed." Ten days later when the erysipelas had disappeared "he applied another plaster case which he left on for eight weeks." When this was removed the Doctor told her she was "cured," and advised her "to have a special boot made to support the ankle."

She hobbled about as best she could for months and finally resolved to come to Buenos Aires to see if something could be done. On February 26, ether was given, and an osteotomy was done. The edges of some chisels and osteotomes were destroyed in the necessary work executed through two large lateral incisions. The limb was placed in a long back splint, with foot piece at a right angle, and side splints added to secure position. The wounds healed up by first intention, the splints were left off at end of six weeks, and on July 18, 1914, she was discharged walking with slight movement in ankle-joint (Fig. 2).

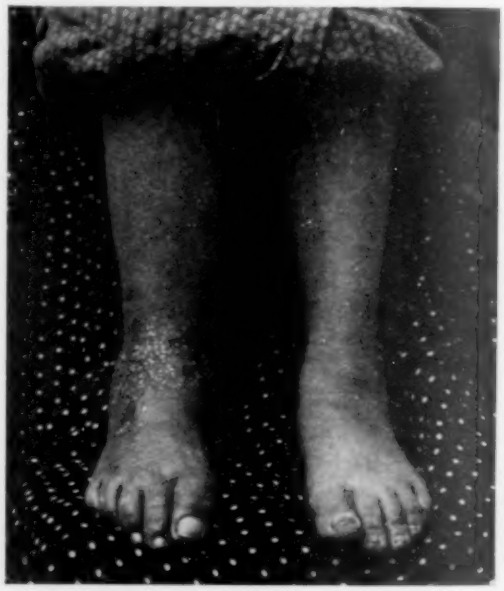

FIG. 2.—Fracture-dislocation of ankle, operative result.

Bridging a Gap Caused by a Compound Comminuted Fracture.—A. B. age forty-seven, workman, was admitted to hospital on the 7th of August, 1923, with the history that while unloading a wagon on that morning three heavy wooden sleepers, total weight 360 kilos, fell from a height of five metres and crushed his right leg. On examination a large open contused wound presented with a widely exposed fracture of the lower third of the tibia and fibula. The limb was placed on a long back splint, and hot perchloride

fomentations applied. The urine contained a large quantity of sugar which, by the way, did not disappear under antidiabetic diet until six weeks later.

August 9, under ether, the wound was enlarged in order to determine the actual condition. The tibia was then found comminuted into five pieces which were detached from the bone ends, and from each other, leaving a clear gap of two inches between the former; The five fragments with their shreds of periosteum were temporarily removed and wrapt up in a bibule while the space was cleared of devitalized tissue. Then arose the problem, what was to be done to fill such a breach in the tibia of a forty-seven year old plethoric glycosuric Italian with, in all probability, an intense septic condition added?

As a forlorn hope the whole wound was liberally washed with peroxide carbolic lotion, the field was then thoroughly dried, and a bridge was built between the ends of the bone with the five broken fragments which were lashed together with strong catgut to keep them in position. The back splint was replaced, with bandages applied above and below the wound, with the foot at a right angle; the external wound was partially united by silkworm gut sutures and a dry gauze dressing applied.

The temperature and pulse remained normal, the sutures were removed on the 14th day. For the ensuing four weeks there was a slight discharge of serum. On the thirtieth day some semi-purulent liquid was observed, peroxide carbolic irrigation, with perchloride fomentations, was begun; four days later the discharge had ceased and a dry dressing was again applied. By the seventieth day the whole wound had healed and something like consolidation seemed to be taking place in the gap. On April 12, as sound bony union appeared to have taken place, the splint was removed, and the accompanying X-ray photo taken (Fig. 3). He was allowed out of bed on crutches April 25 and sixteen days later walked out of hospital on two sticks. A month later he returned to report progress and now could walk without any aid. The œdema which primarily followed walking was gradually decreasing with massage, and there was distinct movement observed in the ankle-joint. Any digression from the special diet was at once followed by a show of sugar in the urine.

FIG. 3.—Gap caused by a compound comminuted fracture of the leg, successfully filled by preserved bone fragments.

Mention of the lashing together of detached spicules of bone by catgut prompts discussion of a detail which I have from time to time found useful in autogenous bridging or splinting of fragments. Many of these cases are septic to commence with and all unabsorbable material such as plates, wire and silk, within a short period becomes an extra handicap. The only thing left is catgut which, at best, is slippery stuff, and as often as not this drawback is intensified by the rotundity and evenness of the surface of the bone which obviously magnifies the difficulty of fixation by such an agent. This obstacle can be overcome by the simple process of making a few slots by a few touches

of a saw, at the strategic points in opposite fragments into which each catgut leash is implanted. This not only prevents slipping of the encircling catgut, but also affords a strong fulcrum for approximation of the bone surfaces by material which otherwise would be useless.

If good alignment is secured on a properly adjusted splint before removal from the operating table, it is the subsequent fortnight which counts, *i.e.*, tissues which have been temporarily divorced have time to renew their natural affinity, not to add that the absorbents have gotten to work, after which disappearance of the foreign body, in the face of sepsis, is all to the good. In aseptic cases I have also found such slots very handy for securing silver wire ligatures.

Elbow Block by Exuberant Callus.—A young man, age thirty, fell off a horse and "his weight came down on the outstretched right hand." He was at once taken to a surgeon who diagnosed backward dislocation of the right elbow-joint. An immediate attempt was made to reduce the luxation. A few days later an anæsthetic was given and another futile effort made. At the end of a week he was taken to the nearest hospital where the diagnosis was corroborated, two X-ray photos were taken, and during the following four weeks the patient had ether three times and bold attempts were made at reduction.

A week later his friends brought him to Buenos Aires, and he entered the British Hospital September 2, 1923. On examination, I found the elbow much swollen, visibly broadened, forearm fixed in extreme extension, the tip of the olecranon could be distinctly felt in normal position. The anterior surface of the joint was occupied by a large mass of bone, which I could only attribute to an intra-articular fracture with enormous callus formation induced by the various attempts to reduce what did not exist. An X-ray photograph demonstrated a large mass of new bone in front of the joint, without any sign of dislocation or other lesion.

A few days afterwards, ether having been administered, a four inch incision was made between the supinator longus and biceps muscles, and dissection carried inwards until the periosteum which covered the hillock of bone was freely exposed. Then by means of strong retractors room was obtained for free division of the periosteum. The latter was next carefully elevated until a large sub-periosteal space was established over and, as far as possible, around the projecting mass. Again with aid of retractors daylight was admitted sufficient to guide me in applying an osteotome and then with gentle taps of a hammer I divided through and around the base of the new formed osseous mass until it was possible to remove it intact through the external wound. It measured three and a half inches in length, three in width and (in centre) one in thickness. The interior of the joint could now be easily inspected, and nothing abnormal was seen except the denuded surface of the humerus from which the block of callus had been evenly removed.

The forearm then could be freely flexed. A wisp of silkworm gut was inserted into the joint, and the rest of the external wound closed by silkworm gut sutures. The limb was bandaged in acute flexion across his chest, with finger tips resting on the opposite clavicle. The drain was removed on the second day, the wound healed aseptically and on the fourteenth day the arm flexed, was placed loosely in a sling, and the patient was exhorted to commence gentle active movement. A week later he had painless movement through an angle of 130 degrees, pronation and supination were normal. Five months later he came back to report progress. Excepting some slight limitation to full extension, he could do everything even to a gleeful demonstration of the fistic art.

Gunshot Fracture of Ankle-joint.—As an illustration of the value of rest in the treatment of traumatic injuries to joints, I am prompted to place on record the following case:

F. R., age twenty-seven, was admitted to hospital, November 19, 1923, with a small infected wound on the inner side of the left ankle which was discharging suspicious looking serum.

The patient stated that on the previous day while packing a handbag, in which he had a loaded 38 Colt revolver, the bag fell on the floor, the revolver went off, and the bullet entered the ankle making this wound. Already swelling had commenced with some cellulitis, the part was very painful to touch, and movement was impossible. Evening temperature 100–101 degrees.

The bullet had entered about one-half inch below the internal malleolus and an X-ray photo demonstrated comminution of the malleolus and of adjoining segment of the astragalus with lodgement of the bullet in the centre of the ankle-joint.

On November 22, under ether, the wound was freely enlarged, four pieces of bone were removed, but although the probe passed easily into the interior of the joint, the bullet was not struck. An anterior incision was then made between the extensor hallucis and extensor longus digitorum, exposing the capsule. After opening the joint, and making downward traction of the foot, the bullet was found wedged between the tibia and the astragalus, with three chips of bone loose in the joint. The bullet and bone fragments were removed, a thorough inspection was then made of the interior of the joint and nothing further found excepting the bare fractured surface of the inner margin of the trochlea of the astragalus from whence the above-mentioned chips had been carried by the bullet into the interior of the articulation.

The anterior wound was closed by interrupted silkworm gut sutures leaving room at an angle for a fine wisp of silkworm gut which was placed at the line of the joint, the enlargement of the original wound was partially closed and a wisp similarly inserted.

Owing to the dry condition of both wounds, the drains were omitted on the third morning; the swelling around had not subsided as much as was expected; the limb since the operation had been maintained at rest on a back splint with footpiece at a right angle. At the end of fourteen days both wounds had healed up aseptically and, notwithstanding that superficial cellulitis was still in evidence, the patient (instructed) moved the joint visibly on the sixteenth day. Ten days later a small tumefaction which had appeared close to the edge of the cicatrix of the bullet wound was incised without striking any apparent septic fluid. As some general œdema persisted the part was kept at rest on splint with perchloride fomentations until February 28, by which date the part had resumed its normal contour. On March 1, he was allowed to get out of bed; there was limited but distinct movement visible in the ankle. On March 15 he walked out of the hospital on a stick with increasing active movement in the joint. One month later he returned to report himself, walking without a stick or a limp, with free and painless movement through a three-quarter range of normal, without any deformity.

During the nine weeks following the first attempt at movement (sixteenth day) the patient was only permitted to practise active movement once daily owing to the pain excited by any extra strain. In order to hasten matters massage was practised, but at the end of a week had to be abandoned as it caused pain and increased swelling.

Gunshot Fracture of the Spine.—S. P., age nineteen, watchman, was admitted to the hospital July 28, 1924, suffering from a revolver injury which had been inflicted that morning at a range of three metres. On examination it was found that the bullet had entered on the right side in the midaxillary line midway between the iliac crest and the last rib. There was complete motor paralysis of the lower limbs with diminution in sensation, and complete paralysis of the bladder and rectum. There was considerable shock, temperature subnormal, pulse 120, delirium and sweating. An X-ray photo showed the bullet lodged in or adjacent to the 3rd lumbar vertebra without sign of fracture. On the third day the temperature suddenly rose to 103 degrees, pulse 130, general condition very grave, and on the following morning jaundice had developed. The patient complained of severe pain when the abdomen, which was visibly distended, was palpated;

there had not been any vomiting, and the bowels had responded freely to purgation and enema. Urine deeply bile stained; no vesical sepsis. As the symptoms suggested severe septicæmia possibly secondary to septic meningitis it was resolved to expose the involved region of the spine.

On August 4 open ether was administered after three days preliminary administration of full doses of liquor strychnia and tincture of digitalis with champagne and brandy. As some particles of lead were observed in the photo marking the course of the bullet from the point of entry to the above-mentioned site in the spine, a corresponding transverse incision was made ending on the opposite side of the vertebral column. When the superficial muscles were exposed the trail of the bullet could not be found, previous use of probe afforded no assistance. The spines of the third and fourth lumbar were exposed and, while some little abnormal gap was felt between them, forcible manipulation failed to detect any crepitus.

Some bulging fibres of the erector spinæ muscle had to be divided to bring the laminæ into sight, then the transverse process of the 4th lumbar was felt comminuted. Owing to the difficulty of working at such a depth an additional vertical incision was made and with aid of strong retractors the broken transverse process was freely exposed. It was broken into three fragments which when removed revealed, at the base of the process, a fracture hole into the spinal canal which admitted the tip of the little finger. Gentle palpation with finger and sounding with probe bent at suitable angles only elicited a small piece of broken bone loose in the canal, this was removed and further search made without result. Judging from the site of entry of the bullet in the skin and the situation of the ragged fracture orifice into the spinal canal, doubt could not be entertained that the bullet had taken a forward and slightly upward course. The possibility of deflection to the side of the body was negatived by the normal condition of the adjoining soft structures. The conclusion was obvious that the missile had entered the spinal canal, had ascended in its lumen or had become buried in the opposite segment of the body of the third vertebra. Partial laminectomy of the 3rd and 4th was then performed sufficient for free introduction of the tip of the right index finger and at about a point half an inch above the upper border of the aperture thus made, something abnormal was felt by finger and probe impacted in the left wall of the canal. By means of a little more laminectomy and leverage by narrow elevator the object was detached from its site and removed intact by a narrow-bladed forceps and found to be a distorted 38 Colt revolver bullet.

The depth of the wound four inches plumb from the level of the skin to the interior of the vertebral canal rendered the operation rather trying on the fingers. There was very little blood lost and no pus seen anywhere. For the additional shock, six consecutive half hourly doses of ten drops of liquor strychnia B. P. were injected. Glucose brandy serum drip with drachm of tincture of digitalis administered ter die. Gangrene with abscess of the left buttock ensued necessitating free incisions and subcutaneous removal of large pieces of deep gangrenous slough. Free drainage was provided with frequent irrigation fomentations. Within six days this complication was dominated and bright red granulations appeared. On the third morning after operation there was notable improvement in the general condition, delirium distinctly less with satisfactory decline in temperature and pulse rate, tongue becoming moist and fortunately no vesical infection had supervened. On the seventh morning, for the first time, felt desire to pass urine—but could not do so. On the ninth day distinct movement was seen in the legs (slight flexion and extension of knee) and he was by this date partaking freely of full diet, stout and egg nog, all sign of jaundice had disappeared. On the twelfth day sensation to touch and pain were normal excepting in feet. He was transferred from the ward to an outdoor balcony on the sixth day after operation. September 12, at the date of this report, his general condition is excellent, the wounds are healing with gradual increase in movement of legs, still unable to urinate.

Ununited Fracture of Shaft of Humerus, with Ankylosis of Elbow and Later Post-operative Musculo-spiral Paralysis. A. F., age thirty-five, a shunter, on July 4, 1922, when getting out from between the wheels received a superficial wound of skin, and a simple transverse fracture of the middle third of the humerus. He was taken to the local hospital on the same date. Here the skin wound was painted with tincture of iodine, and the arm, without splint or bandage, was placed in adduction on a long pillow, and was thus retained for the ensuing two months.

September 1. Union had not taken place in the fracture, and as the elbow was now found to be "stiff" (in extension) an anæsthetic was administered and the arm "forcibly flexed to a right angle, and in this position was encased in plaster-of-Paris. Three weeks later the plaster was removed, and an angular splint substituted. Six days later, as the splint caused pain, it was left off.

October 4 the patient was brought to the British Hospital. On admission he presented a miserable semi-starved appearance, with an ununited fracture of the middle third of the humerus, and with what appeared to be complete ankylosis of the elbow-joint at a right angle. The limb had considerably wasted. His past history was excellent and family one normal.

October 16. Under ether the fracture was exposed by an anterior external incision, the musculo-spiral nerve was not seen, and the fragments, little displaced, covered with interposed tissue, did not present any semblance of union. The bone ends were cleaned and revivified and as they lay in close apposition, they were drilled and lashed together by strong catgut ligatures. The wound was as usual closed by interrupted through and through silkworm gut sutures.

Although the condition of the elbow attracted acute attention, it was resolved to stick to one thing at a time, and endeavor to get the fracture to unite first. The arm was placed on a right angle splint, and in bed rested on a pillow in semi-abduction. The wound healed up by first intention. Six weeks later the splint was removed for inspection, and there was not a sign of union.

As it was puerile to continue with splints, the arm was placed in a sling and the patient was told to move "the thing" all he could. He was at this juncture transferred to the "continuous outdoor," daily massage was installed and diathermy was inaugurated once daily—one pole placed above and behind the fracture, and the other well below the front of the elbow-joint, the idea being to get the current to pass through both ankylosis and fracture.

A few days later, I left on my annual holiday having mapped out a course of massage and diathermy for the patient during my six weeks absence.

On my return to work in March, I was relieved to find that considerable union had taken place in the fracture, and to observe distinct active movement in the elbow. By May, union had consolidated and there was mobility of elbow through an angle of 60 degrees which by the end of July had increased to 90 degrees.

About this date the masseur, who had done fine work in restoring something in the way of musculature which on admission did not seem to exist, called my attention to an intractable drop in the wrist. After slight study there was no escape from the conclusion that the musculo-spiral nerve had somehow became involved in the lesion.

On August 16 an incision was made between the posterior border of the deltoid and the outer head of the triceps, the nerve was exposed, and then traced downwards to the seat of fracture where it, along with some thickened periosteum was found densely embedded in a sulcus corresponding to the outer line of union of the fracture, giving the impression that both had become welded in between the fragments—which by the way were firmly united.

After some dissection the nerve with periosteum were liberated from their osteal grave, and then it was discovered that the nerve had at this point become much attenuated, for about one inch it appeared a mere web of disorganized tissue. This portion was

excised after some difficulty had been experienced in differentiating the distal segment which was obscured in cicatricial tissue, extending a few inches below the line of fracture.

Without prejudice to the high opinion which I have for years maintained as to the value of interrupted through and through sutures in the closure of fracture wounds I think it probable that in this instance, the nerve after original injury had become locally adherent to the periosteum which may account for its not having been seen at the previous operation in spite of a sharp lookout maintained by myself and assistants. Reflecting on the manner in which it was found engaged in this dip in the line of union, I think it logical to assume that the corresponding through and through (including periosteum) suture was responsible for having interred this segment of nerve in the callus trap.

If the above deduction is correct, the moral follows whenever there is an important nerve in the vicinity do not insert through and through stitches blindly through the tissues, particularly through the portion of periosteum in face on the line of fracture.

The limb was now placed on a straight splint and retained on it for six weeks, at the end of which there was movement through elbow of some 120 degrees.

The patient was discharged in January with hand on a cock up aluminum splint. In April he returned, looking sunburnt and stout, for inspection, extension of forearm now amounted to 145 degrees, the muscles had considerably developed, could freely extend the elbow, sensation had returned in the area behind thumb and index finger, but the wrist drop was still marked. He was told to find some light work and maintain the hand in splint until his next visit for inspection.

ON THE RESECTION OF THE STOMACH BY KOCHER'S METHOD

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The article of L. Clarence Cohn, in the Annals of Surgery, of February, 1924 (vol. lxxix, p. 229), entitled, "Pylorectomy followed by Kocher's Method of Gastroduodenostomy in Certain Cases of Carcinoma of the Stomach," has prompted me to write this paper. As the author has stated in that article, Kocher's method is used comparatively rarely. The method most employed is the Billroth II or its modifications. Kocher's method has its advantages in the following points: 1. Rapid operation. 2. Security of the suture. 3. After the resection reconstruction of a form which most resembles the normal stomach. Some other advantages of this method are also ascribed to this last point. The recent tendency to return to the Billroth I is to be ascribed to these several advantages. Kocher's method and the Billroth I are identical in their principle. The most employed Billroth II needs a comparatively long time for the operation, and that brings, of course, bad results. The suture in Kocher's method is the safest; it has no weak point. The suture of the Billroth I is weak at the angle, where the suture of the gastro-duodenostomy meets the closing suture of the cut end of the stomach. Formerly this danger was too highly estimated, but with some care it is not so dangerous, and the opinions of the several authors agree in this point. But it is necessary to add some single Lembert's seromuscular sutures at the angle to ensure safety. This procedure may narrow the opening of the gastro-duodenostomy. By the Billroth I this opening is already narrow, if the cutting line of the stomach is oblique to its longitudinal axis. The narrow opening of the gastroduodenostomy produces several disagreeable consequences.

After the resection of the stomach by the Billroth I the relation of the stomach to the intestine is most natural. If Kocher's method is employed in a short time after the operation the posterior wall of the stomach lengthens and the part of the gastroduodenostomy is placed in a most caudal position; it seems exactly as if the operation had been carried out by the Billroth I.

After the resection of the stomach its evacuation is very rapid. The establishment of the so-called "hubhoehe" is intended to avoid this rapid evacuation of the stomach. Goetze's method[1] of making this "hubhoehe" is to close a portion of the cut end of the stomach from the greater curvature and to implant here the cut end of the duodenum. But it is not demonstrated that the evacuation of the stomach may be retarded surely in this way. Moreover the long existence of this "hubhoehe" is very doubtful. The establishment of the "hubhoehe" is ideal by Kocher's method, but the time of the evacuation of the stomach which has been resected by this method is

[1] Goetze: Neue Ziele der Magenresektionsmethode. Deutsch. Chir. Congress, 1920.

also rapid and is never retarded. Whether the retarding of the evacuation of the resected stomach is preferable or not is an undetermined problem. At any rate clinically, the rapid evacuation never has bad results. The long remaining of the ingesta in the resected stomach, which has no free hydrochloric acid or hypoacid, may be disadvantageous.

In the gastro-enterostomy for gastric and duodenal ulcers the problem of the occurrence of peptic ulcers is very important. This complication is very

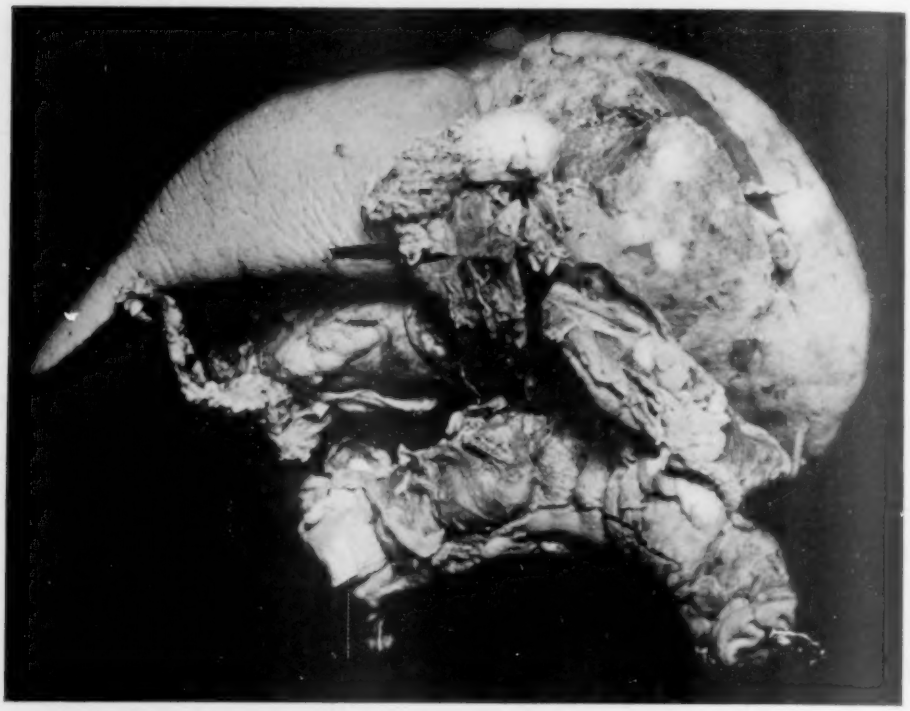

FIG. 1.—Anterior view of the specimen.

serious and disagreeable. The observed cases of this kind of ulcer after resection of the stomach are rather rare. Not one case is reported after resection of the cancerous stomach, but in cases of ulcer after the resection many cases of peptic ulcers have been observed. Von Haberer, of Innsbruck, has expressed the opinion that the removal of the pylorus prevents the occurrence of peptic ulcers, but he has observed one case among his patients, in which the operation was performed by the Billroth I. There are several theories which explain the occurrence of peptic ulcers. In some cases the mechanical injury of the jejunum wall by the clamps seems to be a causing factor of the peptic ulcers. Sometimes the ulcers are situated just on the place where the clamps were applied at the operation. That the silk thread of the suture also may have an influence on the occurrence of the peptic ulcers is proved in some cases. By some authors its development is ascribed to the infection. Many other theories, which explain the pathogenesis of gastric

and duodenal ulcers, are also held. It is probable that the mucous membrane of the jejunum is less accustomed than that of the duodenum to the gastric juice. When the jejunum is employed in the gastro-enterostomy, ulcers are more likely to occur than after gastroduodenostomy.

The operation by Kocher's method is performed in the following manner: The abdomen is opened on the middle line, the stomach and its neighborhood examined and the operability determined. If the resection is undertaken, first ligate the arteria gastroepiploica sinistra and divide at the point where the resection will ultimately be made. The gastrocolic ligament is ligated and divided at as great a distance as possible from the greater curvature. The lymphatic glands along the greater curvature are situated sometimes at a great distance from the gastric border, as Bier has remarked. At the part nearer to the pylorus ligate the arteria gastroepiploica dextra, separate the pylorus and the first portion of the duodenum from the pancreas. In this step of the operation bleeding must be most carefully checked. Now the operator puts his right hand behind the stomach and perforates the gastrohepatic ligament with his finger at a suitable point. From this perforated opening he must separate the lesser curvature of the stomach. The lymphatic glands are placed along the lesser curvature near the gastric border, therefore it is not necessary to resect too much from the minor omentum. It is customary to separate at first towards the pylorus and then towards the cardia. Having reached the point, towards the cardia, where the section of the lesser curvature is to be made, clamps are applied and the operator divides the stomach with scissors. The aboral cut end of the stomach is covered with gauze and fixed with some sutures to the guarded clamps; by this procedure soiling is completely avoided. Then close the oral cut end of the stomach; at first suture continuously through all the coats and invert that end by the continuous seromuscular suture. If some single sutures are employed on both edges at the lesser and greater curvatures, then the inverting is very easy. Without having been cut the duodenum is attached at the posterior wall of the gastric sac by a continuous seromuscular suture; this suture makes the posterior half of the serous suture. Now cut with a knife the semicircumference of the duodenum and the corresponding part of the gastric wall. The posterior half of the inner suture is now introduced, it embraces all the coats of the stomach and duodenum and is applied continuously. When this posterior half of the inner suture is finished, cut the other half of the duodenal wall. Then the anterior half of the inner suture is to be continued. Finally, the anterior half of the serous sutures completes the gastroduodenostomy. In this way the gastroduodenostomy can be carried out rapidly and cleanly.

It is also recommended to divide the duodenum at first, after the separation of the stomach. When the duodenum has been divided, lift the stomach to the left and then the posterior wall of the stomach is towards the operator. The cut end of the duodenum is sutured at a suitable part of the posterior wall of the stomach. The implantation of the duodenum in such a manner is sometimes difficult, when the posterior wall of the stomach is stretched

with tension. In making the posterior half of the seromuscular suture, sometimes the other opposite mucous membrane of the duodenum is sutured together, especially when the clamps are employed. This incident seems not so rare. If the width of the opening of the anastomosis is tested by the finger invaginating the gastric and duodenal wall, the suture separates and the opening becomes all right. Therefore this manipulation must always be performed after making the anastomosis. In this method of operation, the place where the duodenum is implanted must be selected with strict accuracy, otherwise at

FIG. 2.—Colon removed *en masse* with portion of stomach; specimen opened along the lesser curvature of the stomach.

the dividing of the stomach after the completion of the gastroduodenostomy trouble might occur; it must be far enough from the diseased area.

In the text-book of Kocher the operation is described as follows: After being separated the stomach is divided at first, the cut end of the stomach closed with continuous suture and the cut end of the divided duodenum implanted. The operation in this manner is not specially preferable.

The separation along the lesser curvature is performed quite easily and completely, when the stomach, which has been divided at the duodenum, is lifted to the left. In the case of cancer, the lesser curvature must be completely removed. Sometimes it is not easy to satisfy this requirement without lifting the stomach to the left.

The tension of the suture of the gastroduodenostomy is the main hindrance in the performance of this operation. But this hindrance can be avoided when the mobilization of the duodenum is performed. About one or two centimetres on the outside and parallel to the descending portion of the duodenum the parietal peritoneum is incised and the duodenum is separated bluntly from the posterior wall of the abdomen. By this procedure the duodenum becomes very movable. Kocher says that, by adding this manipulation, this

type of the gastroduodenostomy may be applied in all cases. But I believe, as also do other authors, that in some cases the performance of this gastroduodenostomy is attended with great difficulty and another type of gastroenterostomy is preferable.

The radical operation is a recent tendency in the treatment of gastric and duodenal ulcers. In these cases Kocher's method can be employed to a greater extent.

Moynihan has condemned this method in his text-book in the following words: "The immediate union of the duodenum to the stomach by the method

FIG. 3.—Showing the section through the lesser and greater curvature and the colon.

of Billroth and Kocher is not to be recommended. It is not easy to accomplish even after the duodenum has been mobilized—it leads to parsimony of the removal of the diseased areas, and is apt to be followed by a stenosis at the new opening which may call for the performance of gastro-enterostomy in the future stages." This criticism is only theoretical; in reality the conditions point to the opposite conclusion.

I have operated by Kocher's method in 42 cases. Of these 42 cases, five were concerned with ulcerous diseases, and the other 37 cases with carcinoma of the stomach. No deaths occurred in cases of the benign diseases. In the cancerous disease deaths occurred in 7 cases—a mortality of 19 per cent. In two of the patients in these 7 fatal cases the transverse colon was resected at the same time. The deaths in both cases were caused through the faulty suture of the colon. If these two cases are excluded the mortality is 14 per cent. In one of the 5 cases, peritonitis evidently occurred, but at the autopsy no sign of faulty suture was found. In another 4 cases the absence of perito-

nitis was confirmed at the autopsies. In these 4 cases the retention of ingesta was not remarked, and deaths occurred between two and ten days after the operation.

Among the cases of permanent cures, the following case is remarkable. The resection was performed with the gastroduodenostomy followed by Kocher's method and at the same time the excision of the transverse colon *en masse*.

Y. T., fifty-one years old, married, admitted to the Izumibashi Charity Hospital, April 26, 1918, discharged May 21, 1918.

Family history of cancer negative. Till the onset of the present illness very well. One day, at the end of November of last year, he was seized with severe attacks of pain in the upper abdomen, when he was working on his farm. The pain was very serious; he could not keep standing up. The attacks of pain continued for about half an hour and were repeated three times. Finally the patient vomited once that evening, and since that time had no vomiting, but was troubled with frequent epigastric pains. The onset of the pain was independent of eating, and it was confined to the left lower part of the thorax, to the back and to the sacral region. Loss of appetite not evident, stools normal. On March 10 this year he found a mass in the epigastrium. Recently emaciation was evident.

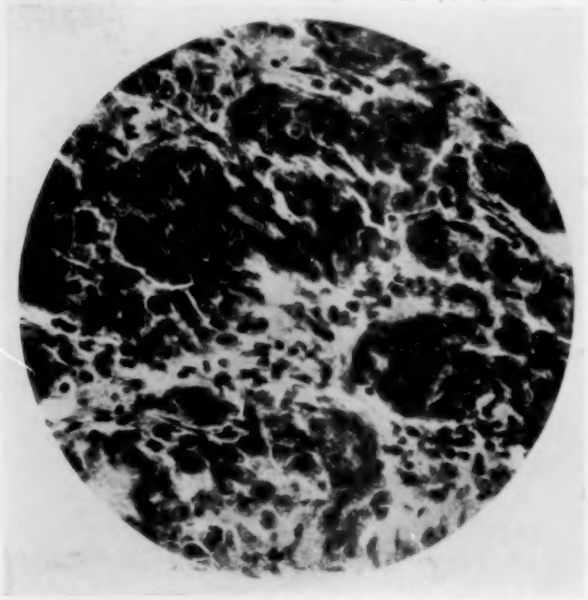

FIG. 4.—Adenocarcinoma of stomach.

On admission not so poorly nourished. Heart and lungs negative. Examination of the abdomen reveals a mass in the epigastrium. Its surface is nodular, the size of an apple, very hard. The tumor moves with respiration, but cannot be fixed on expiration, and is tender. Liver and spleen negative. Gastric contents after Ewald, total acidity 24, free hydrochloric acid negative, the lactic acid positive. Occult bleeding of stools negative.

Operation—April 29, 1918, by Aoyama. Incision on the middle line. The tumor situated on the greater curvature near the pylorus, size of orange, firmly adherent to the transverse colon. Resection by Kocher's method, excision of the transverse colon about 20 cm., and sutured end-to-end.

The course after the operation uneventful. On the 22nd day after the operation the patient was discharged. Now, after fully 6 years, the patient is completely well.

The tumor grew on the greater curvature, penetrated all the coats of the stomach, and was very firmly adherent to the wall of the transverse colon. The histological examination of the tumor revealed adenocarcinoma (Fig. 3). It is a well-known fact that this type of cancer of the stomach rather frequently admits of permanent cure.

Examination June 21, 1924.—No trouble and no discomfort of the stomach. He can

work on the farm as well as when in health before the operation. No sign of the hernia on the place of the abdominal section. The cicatrix is lineal. Neither a mass, nor the tenderness in the abdomen. Examination of the gastric contents with Rehfuss's tube revealed following results:

Time, minutes	Total acidity	Free acid
15	5	0
30	10	0
45	10	0
60	15	5
75	22	10
90	40	32
105	24	12
120	30	15
135	evacuated	

Residuum nil.

Before the operation the absence of free hydrochloric acid in the gastric contents was confirmed; it has appeared now again.

ACUTE PANCREATITIS

By Sir Berkeley Moynihan, F.R.C.S.
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Acute pancreatitis is the most terrible of all the calamities that occur in connection with the abdominal viscera. The suddenness of its onset, the illimitable agony which accompanies it, and the mortality attendant upon it, all render it the most formidable of catastrophies. The disease (in accordance with the classification suggested by Fitz, of Boston, one of the greatest of physicians, who first described it in the year 1889) is generally said to be of three types, hemorrhagic, gangrenous and suppurative. The three types differ only in degree. In the most acute form of all, which is rapidly fatal unless an early operation is performed, hemorrhage is found throughout the whole gland. In a less acute form the patient may survive to discharge sloughs of the pancreas, and of the necrosed fat around the pancreas, for many weeks after operation; in a still more chronic form, an abscess in and around the gland may form so slowly that there is time for it to point in front, or in the costovertebral angle. The essential nature of the disease is the same in all three forms. Of the cause of the disease we are at present ignorant insofar as the great majority of the cases are concerned.

Symptoms.—It is generally stated, even by the most competent authorities, that acute pancreatitis is a disease difficult to recognize; that the diagnosis will often be made only when the abdomen is opened, and a blood-stained effusion escapes, or areas of fat necrosis in the parietes, or in the omentum, are discovered. I cannot agree with such opinions. The clinical picture presented by a case of acute pancreatitis is quite unmistakable. It is because the surgeon omits to think of this disease that its presence escapes him. As Deaver says: "Unless a surgeon has seen previously two or three cases of acute pancreatitis, or unless he keeps the condition constantly in mind, it is seldom that a correct diagnosis is made before opening the abdomen." So many forms of abdominal disaster are seen, and among them so few involve the pancreas, that thought of this organ slips from the memory. I have found in not a few instances, that the moment the diagnosis is suggested, it meets with eager acquiescence. The first and chiefest symptom is pain; and of all the pains that the human body can suffer, this is by far the worst. Even the agony caused by the perforation of a gastric or duodenal ulcer is less than that in acute pancreatitis. The pain, too, is remarkable in that it comes so frequently after a good meal, and for the area of its distribution; it is of fiercest intensity in the epigastrium, but it is felt also in the back and often in both loins. Pain in the back is rare after the perforation of an ulcer, even of an ulcer eroding the pancreas, and perforation of such an ulcer is of far rarer occurrence than acute inflammation of the pancreas. The pain is so intense that it causes profound collapse, in which the pulse rises rapidly and

loses volume, and the blood-pressure falls. Almost every writer upon the subject of perforation of ulcers of the stomach or duodenum, speaks of "shock." It is true that the patients look profoundly ill, having white and anxious faces; but the pulse in these cases remains almost unchanged in frequency and in volume, and the blood-pressure is little altered. It cannot, therefore, be quite accurate to speak of "shock" as a symptom of perforation, for the conditions inseparable from shock are in this case absent. The collapse of the patient is evident enough, and such a state exists as to render any operation of a far greater severity than normally attaches to it. Of the existence of "shock" in acute pancreatitis there is never the slightest doubt. The patient is prostrate, faint and pallid, and suffers indescribable anguish; the pulse may be hardly perceptible, the limbs and face are cold, and death itself seems imminent. No such state is seen in any other form of casualty. There is all the collapse that even the greatest hemorrhage could cause, and more than the agony of a visceral rupture. Corroboration of a diagnosis made upon these evidences alone is hardly necessary; but if it were it is never lacking. Vomiting is almost invariably present, and it occurs early. There are cases in which it is repeated with great frequency and severity, so that the resemblance to a case of high intestinal obstruction, in respect of this one symptom only, is very close. The matters ejected are, however, never in the least like those seen when the jejunum is obstructed in its upper part; they are of gastric, or of duodenal origin, never foul-smelling, and never copious. Nausea and retching, with hiccough, are more frequent here than in cases where the intestine is blocked. The patient sometimes presents a very curious, and I believe, a quite characteristic appearance, to which Halsted was the first to call attention. The face is livid, and patches of a slate-blue color may be distributed irregularly over the surface of the abdomen, or even of the limbs. This cyanosis is never found in other forms of acute abdominal catastrophe, so far as I know; it is not always present in acute pancreatitis, but if it is found, it is, I believe, an undeniable evidence of acute pancreatic disease. Grey Turner has recorded (Brit. Journ. Surg., 1919, vol. vii, p. 394) two cases in which large patches of discoloration of the skin were attributed to direct action of the pancreatic juice which by infiltration had reached, in the one case the umbilicus, and in the other the costo-vertebral angle. I have seen a faint tinge of jaundice in five cases only.

The respirations are quickened in all cases, and are faint and shallow in proportion to the degree of collapse, which is in turn dependent upon the degree of swelling in, and around, the pancreas. An examination of the abdomen makes the diagnosis still more certain. There is a degree of rigidity in the whole abdomen, and the epigastric region is certainly a little firmer than the rest. But the fixity and hardness are not to be compared with the conditions present when a hollow viscus has burst. Then the rigidity is obdurate and unyielding, and immobility of all the abdominal muscles, including the diaphragm, is complete. The lightest handling is then resented. In acute inflammation of the pancreas, however, the rigidity, and a degree of

tenderness, are confined to the parts above the umbilicus, and even in early hours a degree of fulness may be observed here. The whole abdomen is tender, but the tenderness is more acute above the umbilicus than below, and often is far more exquisite to the left of the middle line than to the right, a point not without significance. If the patient survives a few days, as will happen in the less acute cases, the contrast between the upper protruding parts of the abdomen, and the emptiness, or even retraction of the lower parts may be very striking. This is the condition to which Fitz gave the name "epigastric peritonitis."

The symptoms I have now described occur only in the gravest form of pancreatic necrosis. If they are less acute, they indicate a degree of inflammation in which the necrosis and the hemorrhage are less extensive, in which perhaps, a rupture of the pancreas into the lesser sac (the "perforation of the pancreas" of W. J. Mayo) does not occur. It may be that in some of these cases the invasion of the gland occurs through the duct of Santorini, and that only a part, and that perhaps a small part of the gland is attacked: the fact that some patients give a history of earlier attacks makes this suggestion not unlikely. All the manifestations of the disease are in this case subdued, and the patient may gradually improve for three or four days. Then the temperature begins to rise at night to 102° or 103°, falling in the morning almost to the normal; vomiting becomes distressing and exhausting, wasting is very evident, and the epigastric fulness gradually increases. A swelling may appear behind, between the last rib and the iliac crest, and additional evidences of pancreatic disease may then be elicited. Of these "Löwe's test" is of no little value. Two or three drops of a 1/1000 solution of adrenalin are allowed to run slowly on to the conjunctiva of one eye; after a few minutes this dose is repeated. Within 15 to 30 minutes the pupil of this eye becomes dilated in cases of pancreatic disease, and remains unchanged in cases where disease is absent. Urinary changes may also be noticed. Glycosuria is not infrequent, but its absence means nothing. Diastase, normally present in small quantities only, is increased tenfold, or even more. Cammidge's reaction, in the hands of its inventor, has proved useful, but other observers have not found cause to rely upon it.

The differential diagnosis in cases of acute pancreatitis should present little difficulty. The more acute the case the easier is the recognition. No other catastrophe within the abdomen produces at once such unendurable agony, and so profound a collapse. Intraperitoneal hemorrhage, resulting from a ruptured tubal gestation, causes intense prostration, blanching, loss of volume in the pulse with increase in its rate, but relatively, the pain is almost negligible, and the site of it is different. The abdomen in these cases is fuller below than above. The history of a missed period and perhaps of a little vaginal hemorrhage, at the time of the onset of pain, are incidents suggestive of a catastrophe of this kind.

The perforation of a gastric and of a duodenal ulcer occurs, in the great majority of instances, in patients who have suffered from dyspepsia for

years, and have undergone one or more periods of medical treatment for its relief. The pain is very severe, but it does not reach the fierce intensity of that experienced in acute pancreatitis; and "shock" as measured by pulse-rate and volume, and fall of blood-pressure, does not occur. For some years I have given special attention to the appearance and condition of a patient in the early hours after perforation of an ulcer has occurred. The pulse, it is always a surprise to find, is very little changed from the normal. In pancreatitis the pulse is so poor, and so rapid, that it can hardly be counted. The abdominal rigidity in perforation is far more inflexible and widespread, and vomiting does not occur with such frequency. There is no lividity of the face, but rather a pallor with sweating of the brow and temples.

A patient who suffers from hepatic colic is restless, moaning and twisting, changing his position every moment, searching for relief which does not come. He folds his arms across the abdomen and doubles himself over them; he presses the abdomen against the back of a chair, or on the edge of the bed: rests for a few moments and walks about, groaning in agony. A patient who has suffered the perforation of an ulcer is motionless; and in acute pancreatitis is almost so. The history of former attacks of the like kind, of flatulence causing great distress, and possibly of jaundice following upon the pain, may help to make the diagnosis clear.

Acute intestinal obstruction may cause the closest mimicry of the symptoms of pancreatitis. Fitz, in his original paper, spoke of epigastric peritonitis with the symptoms of high intestinal obstruction, as being significant of this disease. The onset of the symptoms, when the intestine is caught and closed, may be acute, but there is nothing of the sudden and overwhelming seizure that is seen in acute pancreatitis; nor is there collapse. Vomiting is projectile, and the ejecta are progressively more and more offensive. General abdominal distention with perhaps a local inflation of an obstructed coil, recognized after a long scrutiny and the gentlest palpation, will be distinguished without difficulty from the appearances of distention above and flatness below, which are so frequent when the pancreas is involved. In acute pancreatitis a local distention of the transverse colon may sometimes be noticed.

I do not know of any case in which the victim of an attack of acute pancreatitis has been regarded as suffering from poisoning. Leriche and Arnaud (Rev. de Gynæc. et de Chir. Abd., 1909, vols. iv and v) have suggested that in the fulminating cases of pancreatic apoplexy, when the onset is sudden, the collapse profound, the vomiting severe, and a fatal ending not long delayed, the likeness to the symptoms caused by an acute irritant poisoning may well excite uneasy suspicions in the mind of the medical attendant.

When all the cases that I have seen are reviewed, the truth remains, that it is chiefly because the suspicion of this comparatively infrequent disease does not enter the mind that an accurate diagnosis is not more often made. The symptoms and the signs are clear enough.

The cause of acute pancreatitis cannot always be determined. The close association of the common bile duct with the head of the pancreas, the rela-

tionship of this duct with the canal of Wirsung at their termination in the duodenum, the presence of the sphincter of Oddi at the ampulla of Vater, have all helped to foster a belief in the dependence of pancreatic inflammation upon causes arising in the biliary passages. And further, the frequent association of cholelithiasis with pancreatitis, both acute and chronic, has done much to strengthen this belief.

The common duct is completely embedded in the head of the pancreas in approximately three cases in four; in the remaining case, there is a deep groove in the posterior surface of the head of the gland, to receive the duct on its way to the duodenum. A degree of inflammation sufficient to attack all the walls of the duct will, therefore, inevitably spread to the head of the pancreas; the more acute the inflammation and the longer it continues, the greater will be the change produced in the gland. The termination of the common duct in the duodenum is in relation with the canal of Wirsung. Four different modes of association are found. (1) The two ducts end in a cavity which discharges into the duodenum by a small orifice. (2) The common duct is joined about one-third inch above the duodenum by the duct of the pancreas. (3) The two ducts open separately but close together on the surface of a depression in the duodenum. (4) The two ducts open similarly but on the surface of a papilla in the duodenum. In the first two forms any block below the point where the two ducts come together will convert them into a single channel. In the last two any blockage of one duct has no effect upon the other. A further intimacy between the biliary system and the pancreas exists through the agency of the lymphatic system. Attention was first called to this by Maugeret (Thèse de Paris, 1898). It is suggested that in cases of gall-bladder infection, a lymphangitis spreads downwards to the common duct, and thence to the pancreas, causing on its way an enlargement of the cystic gland, and of the glands which lie along the duct. The recent work of Braithwaite (Brit. Journ. of Surgery, 1923, vol. xi, p. 7) has shown, that when one lymph channel is blocked, a retrograde current is set up, and the flow occurs through other channels. A pancreatic lymphangitis may be set up by infective material coming from the gall-bladder and turned aside from its main direction of flow by a block in the enlarged glands.

In acute pancreatitis, the immediate cause of the gland necrosis is the activation of the pancreatic juice by some agent or other, within the substance of the gland. In normal conditions the trypsinogen of this secretion is converted into trypsin by an enterokinase in the duodenum. A reflux of the activated juice into the gland is physically impossible. An increase of the intraduodenal pressure to 1000 mm. of water does not overcome the resistance of the ducts. It is impossible by experiment to force back the duodenal contents into the ducts (Archibald, Surg., Gyn. and Obst., 1919, vol. i, p. 531). The problem, therefore, is to discover what agency is competent to cause the activation of the pancreatic juice before it leaves the gland.

The first demonstration of the influence of the bile, in this respect, was

given by Claude Bernard in 1856. He produced acute necrosis of the pancreas by the injection of bile mixed with sweet oil, into the duct of the pancreas. For many years after this an association between cholelithiasis and acute pancreatitis had occasionally been noticed, but attention was especially directed to this subject in 1901 by Opie, in his work on "Diseases of the Pancreas." On examining the body of a patient of Halsted's, who had died from acute pancreatitis, Opie found that the common duct and the canal of Wirsung ended in a common cavity, a diverticulum, the outlet of which into the duodenum was small: this outlet was completely blocked by a calculus which did not fill the diverticulum. In consequence the ducts became converted into a single channel, and a retrojection of bile into the canal of Wirsung, stained a deep green color, had occurred. This led Opie, Flexner, and others to study the effect of the experimental injection of bile, bile salts, and chemical irritants of several kinds, into the pancreatic duct. Pancreatitis, strictly comparable to the condition met with in man, was found. In all these experiments the injections were made by a syringe, with a greater pressure than could be produced by any agency during life. Nordmann's experiments (Archiv f. klin. Chir., 1913, vol. cii, p. 66) appeared to show that two factors were necessary to the production of acute hemorrhagic pancreatitis in the dog, (a) stasis of pancreatic juice within the ducts of the gland, (b) the access of organisms with, or without, bile to the duct. Polya's experiments (Mitt. a. d. Grenzgeb., 1912, vol. xxiv, p. 1) demonstrated that typical pancreatic necrosis with hemorrhage, and fat necrosis, causing death rapidly, was most readily produced by the intraductal injection of a strongly active trypsin solution, less constantly by the injection of duodenal contents, or by bile mixed with bacteria, and rarely by the injection of bacteria alone or of the discharges from intestinal fistulæ.

Mann, of the Mayo Clinic, has conducted a series of experiments upon goats (Mayo Clinic Papers, 1921, vol. xiii, p. 185). In these animals, the pancreatic duct enters directly into the common duct a few centimetres above the duodenum. A ligature applied to the duct below the entrance of the canal of Wirsung, converts the two ducts into one channel. After such an operation the animals lived sometimes three or four weeks. The pancreas was then deeply stained with bile, and all the ducts of the gland were filled with bile. Acute pancreatitis did not develop. If, however, the common bile duct was ligatured above the entrance of the pancreatic duct, and through a cannula placed in the lower part of the duct, bile drawn from the goat's gall-bladder was injected into the pancreatic duct, acute hemorrhagic pancreatitis developed and caused death. The pressure of bile in the common duct, he found, was due to three causes: the secretory pressure of the bile, the contractile pressure of the gall-bladder, and the pressure of the abdominal muscles. The secretory pressure of bile was assessed at 350 mm. of bile; the contractile pressure of the gall-bladder at 300 mm. as a maximum, though usually it seemed "of little consequence." The mechanical effect of the abdominal muscles and of the diaphragm produced the most marked changes upon the pressures within

the duct. Deep respiratory movements, struggling, retching and especially vomiting, caused the pressure to reach as much as 1000 mm. of bile. If bile was injected at this pressure, directly into the pancreatic duct, acute pancreatitis did not develop, except in one case where there was fat necrosis of the gland. The difference in the results of injection of bile with a syringe and at the lower pressures seemed to be due to trauma, to the rupture of the small pancreatic ducts and to infiltration of the gland substance by bile when the syringe with its higher pressure is used.

Mann examined the condition of the common bile duct, and the pancreatic duct, in 200 consecutive bodies in the post-mortem room, and found that in 40 only was there the condition of the ampulla described in Opie's case. He gave the following table:

Group	Location of opening of pancreatic duct	Number of specimens	Percentage
1.	Separately into duodenum	62	31
2.	Two mm. from the apex of ampulla of Vater	90	45
3.	Three mm. to 10 mm. from the apex of the ampulla of Vater	40	20
4.	Duct absent or reduced to fibrous cord	8	4
	Total	200	

Archibald has suggested (Surg., Gyn. and Obstet., 1919, vol. xxviii, p. 529) that the mechanism by which the two ducts are converted into one may be the sphincter of Oddi. This muscle, described by Oddi (Arch. p. l. Sc. Torino, 1888, vol. xii, p. 333) had escaped the notice of all surgeons until Archibald called their attention to it. The following brief account of Oddi's work is given by Archibald:

"Oddi studied this muscle both physiologically and anatomically. In brief, he found that the sphincter in dogs was able to resist a pressure of 50 millimetres mercury, which equals about 675 millimetres of water. He demonstrated in microscopical sections, that the sphincter was composed of a special bundle of circular fibres. He found that the common duct, outside its course through the bowel wall, possesses no muscular fibres. From the physiological side, he discovered that this sphincter could be put into spasm by a mechanical irritation of the duodenal mucosa, or by the application of dilute hydrochloric acid in either the duodenum or the stomach; and that even mere cutting of the bowel to expose the papilla would cause spasms lasting from twenty to thirty seconds. Stimulation of the vagus apparently provoked a very prompt and intense contraction of the sphincter. A like result was obtained by stimulating the central end of the cut sciatic, while stimulation of the splanchnics had no effect. He also observed dilatation of all the extrahepatic ducts in dogs deprived of their gall-bladder. He thought a catarrhal condition in the duodenum was a stimulus to the sphincter, and that this might explain some cases of icterus where other causes could not be found."

After a series of experiments, Archibald concluded that the lesions indicating the existence of an acute pancreatitis were brought about entirely through the action of the sphincter of Oddi, combined usually, but not always, with some increase in pressure in the biliary system behind the sphincter. The effect of the bile, or of its salts, is to cause a cytolytic effect, a direct disintegrating effect, upon the cells of the pancreas (Bradley and Taylor,

Journ. Biol. Chem., 1917, vol. xxix, p. 281). This work of Archibald encouraged Mann to undertake a further series of investigations upon the anatomy of the sphincter in man. It is evident that if the sphincter is to be able to convert the two ducts into one channel, it must lie distal to the entrance of both the ducts into the ampulla: otherwise it would merely compress the lower ends of the two ducts. In most instances Mann found that the position of the muscular fibres was proximal to the termination of the common bile duct, and that some fibres also passed round the lowest part of the canal of Wirsung. By their contraction, the two ducts would be narrowed. In rare instances, that disposition of the sphincter was found which would close only the outlet of the ampulla and so lead to a free communication between the two ducts.

The conversion of the two ducts into one, by the closure of the outlet from the ampulla into the duodenum, by the action either of the sphincter, or of a stone, seems to be possible only in 4.5 per cent. of the total number of bodies examined (E. S. Judd, Journ. Amer. Med. Assoc., 1921, vol. lxxvii, p. 197). The conclusion has therefore been drawn, that the occurrence of acute pancreatitis as a result of the injection of bile into the duct of the pancreas, must be "exceedingly small." But may not the conclusion be drawn with greater likelihood, that it is only those patients in whom the anatomical or physiological conditions are favorable, who suffer from acute pancreatitis? Those conditions are present, it is true in only 4.5 per cent. (Judd) of the total number of bodies examined: but is it not possible, indeed probable, that they are present in a large proportion of those patients who suffer from acute pancreatitis? The incidence of this disease is very rare in comparison with many other forms of abdominal catastrophe; its rarity may well be due to the fact that the essential conditions for its development being absent, most people are safe from its attack. The examination into the exact anatomical conditions present in all the fatal cases, can alone answer these questions. The two conditions, which may be considered as almost essential in the development of acute hemorrhagic pancreatitis, appear to me to be (1) an anatomical arrangement of the parts at the termination of the two ducts, which permits of their conversion into one channel by closure of the orifice of the ampulla into the duodenum, and (2) the presence of infected bile, associated or not with cholelithiasis, in the gall-bladder or in the bile ducts.

The possibility of the duct of Santorini being the only duct or the larger of the two ducts of the pancreas, the duct of Wirsung being absent or very small, must be remembered. This condition is found in 10 per cent. of bodies examined. The duct of Santorini opens directly into the duodenum without any protective mechanism at its termination. The entrance of duodenal contents into the duct may accordingly take place under conditions which would be powerless to effect an entrance to the canal of Wirsung. A case of acute pancreatitis where the necrosis of the gland was limited to the area of the duct of Santorini was recorded by Opie in the first edition of his work. Other

cases have since been observed; the area of the necrosis of the gland being large or small, in proportion to the extent of the gland which is drained by this duct. Brocq (Compt. Rend. Soc. de Biol., 1919, vol. lxxxii, p. 371) has shown the potency of duodenal contents injected into the ducts in setting up an acute inflammatory condition, with hemorrhage, and he found also that normal bile will produce necrosis of the gland if it is injected during the progress of digestion.

An acute lymphangitis can play little part in the onset of the most acute forms of pancreatitis. The disease is too sudden in onset, its ravages too widespread and too intense for that. The essential quality of the disease is auto-digestion of the pancreas, and that can rapidly occur only through an invasion of its duct.

Treatment.—There can be no doubt that recovery from acute pancreatitis, of all grades, except the most severe, is possible without operation. In a number of cases in which I have operated for stones in the gall-bladder, or in the common duct, very extensive areas of fat necrosis have been found, and the pancreas has been large, infiltrated with blood, and œdema around it has been considerable. In one patient, a medical man, accustomed to the practice of surgery, the diagnosis of acute pancreatitis had been made by himself. He was able to detect an "immense difference" between the ordinary attacks of hepatic colic to which he had long been subject, and the last attack which was "beyond everything," and in which, his partner said, he had nearly died. It is, however, equally certain that recovery from this disease, apart from operation, is so rare that no case should be left untreated. Not all the operations that have been practised have helped in the recovery of the patient: for a few instances are related in which the abdomen was opened, the diagnosis made, and the wound closed without anything more being done. Recovery in such circumstances would probably have occurred if the patient had been left alone.

The procedure I adopt and advocate consists—(a) in the opening of the abdomen by a paramedian incision above the umbilicus; (b) the gaining of access to the pancreas sometimes above the stomach, through the gastro-hepatic omentum, sometimes below the greater curvature through the gastro-colic omentum, sometimes, though rarely, through the transverse mesocolon, after the omentum has been turned upwards; (c) the isolation of the pancreas by gauze packing covered by mackintoshes; (d) the evacuation of any fluid around the pancreas, by aspiration if the quantity is large; (e) incision of the capsule of the pancreas to allow the escape of blood, of fluid, or of sloughs already detached from the pancreas, or resulting from necrosis of large areas of fat; (f) adequate drainage through the anterior abdominal wall, a drainage tube being surrounded by gauze so as to create a barrier of lymph around the area as speedily as possible; (g) posterior drainage when necessary; (h) cholecystotomy (rarely cholecystectomy) if stones are present, or the gall-bladder appears diseased.

The diagnosis is almost invariably made before the operation commences. In the fat of the abdominal wall, areas of fat necrosis may be seen before the peritoneum is opened. As soon as the abdominal cavity is reached blood-stained fluid escapes. Whatever doubts may have been previously felt as to the nature of the disease, they are at once resolved when these two conditions, fat necrosis, and sanguineous exudate, are found. In a very large proportion of the cases a great, but local, dilatation of the transverse colon, below the pancreas is found. The colon here is not only much larger than either the ascending or the descending colon, but it is congested in appearance, sometimes very deeply congested, or even inflamed. The condition of the pancreas and of the parts around varies very much. In the most severe cases the pancreas is a phlegmon filled with blood, deep purple in color, looking ready to burst. In the less severe cases, hemorrhage into the gland is only slight and patchy, and a little turbid blood-stained fluid is found either in the lesser sac or behind its posterior layer.

The isolation of the pancreas at this stage is very important. The fluid about the pancreas is extremely toxic, and its escape into the general cavity of the peritoneum, followed by its absorption, might gravely affect the result of the operation. A dread of this result has influenced many surgeons in their refusal to incise the posterior layer of the lesser sac, and the capsule of the pancreas. It is a mistake not to give vent to this exudate; it can be evacuated without any risk, if adequate care is taken, and after all absorption is more likely to take place from the pancreas itself, or from the cellular tissue around it, if this fluid is allowed to remain under great tension. Incision of the pancreas itself need never be made. If the gland feels very œdematous and soggy, the finger may be very gently insinuated into it here and there, so as to make points of escape for retained secretions and blood. Drainage must be free. In a week or ten days after operation a copious discharge of a dirty looking, turbid, blood-stained fluid with sloughs, large and small, may occur. Displacement of the rectus to the outer side will do something to prevent the development of a hernia subsequently. If a hernia develops it can be repaired; if drainage is not adequate the patient will die.

The question as to what shall be done in respect of the gall-bladder will depend upon two considerations, the general condition of the patient, and the state of the gall-bladder itself. Whatever the condition of the patient may be, if stones are present in the gall-bladder or common duct, a tube should be placed in the gall-bladder, as many stones as possible being removed from them both. The complete emptying of the gall-bladder, or its removal may be left to another day, but a drainage tube in the gall-bladder will allow the escape of bile and prevent any great pressure within the ducts. If the patient's condition permits it, complete evacuation of the stones should be possible; or, in the most favorable circumstances, cholecystectomy may be considered safe. The margin of safety must not be overstepped. The surgeon is operating to save a life in jeopardy; not to cure his patient of cholelithiasis. If the patient is very ill, and very stout, having a gall-bladder

shrunken and fibrotic, buried in adhesions and inaccessible, it is safer to leave matters alone. Archibald, of Montreal, whose work on pancreatitis is characterized by great industry and insight and by much ingenuity in the suggestion of experiments, has advised that the duodenum should be incised, the ampulla of Vater slit open, and the sphincter of Oddi divided, in order to prevent the retention of bile, and its confirmed passage into the duct of Wirsung. I have not used this method in any of my cases, never having found a stone in the ampulla in this disease. The objection to its routine employment is, of course, that it is applying to all patients a method, difficult and time-consuming, which may only be of value in a small proportion of them.

THE TREATMENT OF CHRONIC RECURRENT DISLOCATION OF THE SHOULDER BY CRUCIAL CAPSULAR PLICATION

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This paper is based on a series of eleven non-epileptic cases, varying in duration from three to twenty-one years, all of the anterior type. While the mechanism of the shoulder-joint, as a whole, might well be considered as wonderful, it is far from perfect as a joint, if the bony structures and muscles are considered without taking into consideration the dense fibrous capsule.

The great difference of opinion as to every supposed etiological factor outside of the primary dislocation and incidental tear of the capsule, shows that this condition is but incompletely understood. All authorities seem to agree that the primary dislocation causes an injury to the capsule which may vary from an actual avulsion of its bony attachments to an irregular tear. Bony defects of the humeral head and glenoid margin have been shown to play an important part in a small percentage of cases, especially where a detached fragment of bone impinges on the glenoid margin or is free in the joint cavity. The influence of muscle support on joint balance has also been emphasized. Injury to the supraspinatus, infraspinatus, subscapularis, teres major, latissimus dorsi and pectoralis major may, by change in tension, influence a small percentage of recurrences.

The head of the humerus is lower in certain cases of long standing recurrent dislocation, as pointed out by some writers, and such dropping is not completely corrected in cases of long duration by upward pressure of the humerus even after the joint is exposed. If this dropping is due to injury to the supraspinatus and infraspinatus muscles, as claimed, it is not evident to the same extent following direct injury to these structures or following experimental division on the cadaver, if the dense capsule remains intact. Muscle atrophy is also supposed to be an important factor in re-dislocation, but the most extreme atrophy incident to avulsion of the brachial plexus is seldom complicated by dislocation if not accompanied by injury to the capsule. The muscular development in this series was normal; and there was no relaxation of other joints, except in one case.

It was demonstrated during the late war that almost any of the muscle groups named as influencing dislocations could be lacerated beyond repair, and dislocation did not occur if the capsule remained intact. It has also been demonstrated on the cadaver that with even a medium laceration of the capsule, dislocation is easily accomplished regardless of the fact that the surrounding muscles are intact.

Dislocation occurs most commonly when the individual endeavors to reach some object higher than the shoulder, and the reason for this seems evident,

even in the normal capsule, if examined when the arm is raised to the vertical position, which produces marked relaxation of the capsule just above the anterior inferior angle, and still greater relaxation as the arm is carried to the side of the head.

While this condition is not very common in the military service and there are cases of long duration that have only one or two dislocations a year and do not require radical measures, there is also a certain percentage of cases both

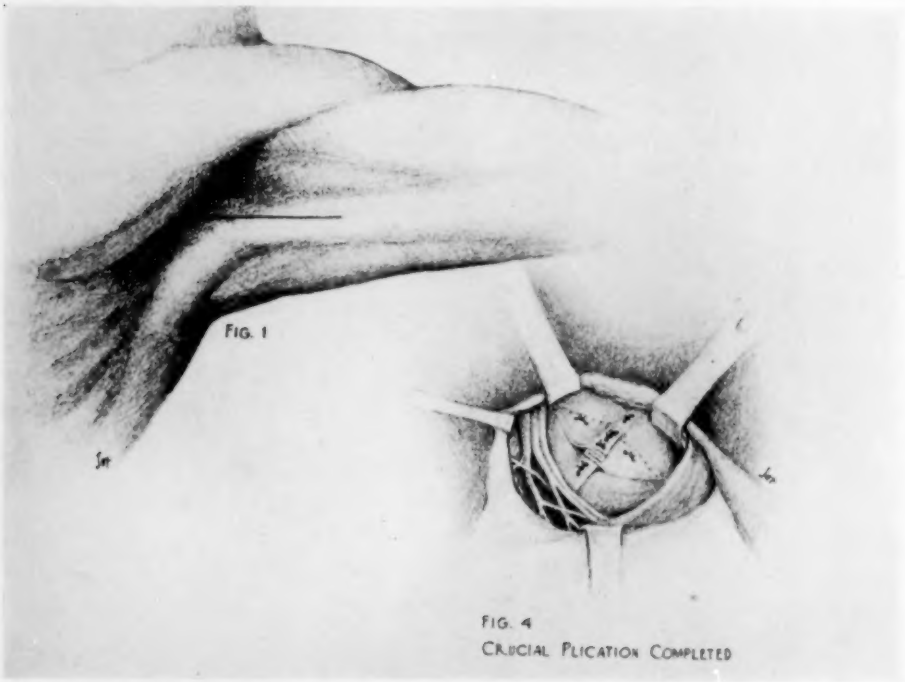

FIG. 1.—Skin incision to expose capsule. FIG. 4.—Crucial plication completed.

in the active service and referred by the Veterans' Bureau that are absolutely incapacitated and can only be relieved by radical measures.

Treatment.—As this condition is primarily preceded by some form of trauma of sufficient severity to produce dislocation of the humeral head with tearing of the capsule, it goes without saying that proper rest and treatment of the acute form in the position of adduction and internal rotation by suitable bandaging, will markedly lower the percentage of cases that become chronic.

Of the numerous incisions for approach, none seem less traumatizing than the practical posterior method of Turner Thomas, which does much to simplify this procedure. The technic of the operation briefly is as follows:

An incision is made posterior to the axillary vessels over the humeral head where the posterior axillary fold fuses with the arm, as shown in Fig. 1. After cutting through the skin and fascia, the tendon of the latissimus dorsi is exposed and immediately above it the subscapularis muscle, as shown in Fig. 2. The space between these structures

is widened by blunt dissection and the capsule is exposed by retraction of the subscapularis muscle upward and inward. The circumflex nerve is isolated and the branches of the subscapularis vessels which pass backward through the space are retracted. At this stage it is necessary to free the capsule more completely by blunt dissection than is usually practiced in the ordinary capsulorrhaphy operation. The capsule is incised, midway between the glenoid and the humeral attachments, upward and downward as far as it is possible to reach. The open joint is explored for loose bodies which, if present, are removed.

The arm is now elevated to the vertical position to relax the capsule and all sutures are introduced, but not tied, as shown in Fig. 3. At this stage of the operation, the arm

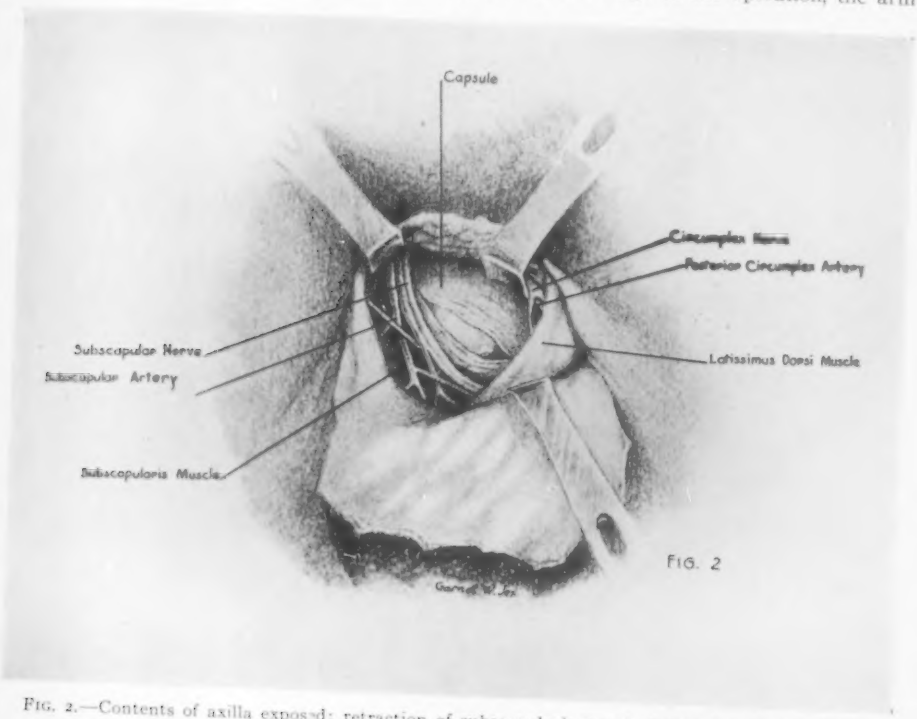

FIG. 2.—Contents of axilla exposed; retraction of subscapularis muscle brings capsule into view.

is carried close to the side of the head and all sutures are tied; and the crucial plication is completed while the arm is held in the position of greatest capsular relaxation and close to the angle at which dislocation most frequently occurs. A rubber tissue drain is carried down to the capsule and removed in twenty-four hours.

The deep structures are closed by a few interrupted sutures and the skin is accurately approximated.

The arm is bandaged to the side for three weeks and gradual upward motion is increased for two weeks more, and after this time, the patient is allowed to proceed with all normal movements.

On one of the first nine cases the patient was what might be termed loose jointed and the operation was a failure, but there has been no recurrence in the others.

There was some slight stiffness a year after operation in a case of twenty-

one years' duration, who claimed to have had his arm dislocated over two hundred times, but the stiffness did not incapacitate him.

In the two last cases sufficient time has not elapsed since the operation to determine the final results.

It has been shown by the compiled statistics of the Zurich Surgical Clinic that acute shoulder dislocations constitute fifty-two per cent. of all acute joint dislocations and that ninety-four per cent. of all acute shoulder dislocations are of the anterior type, which makes it natural to suppose that a like propor-

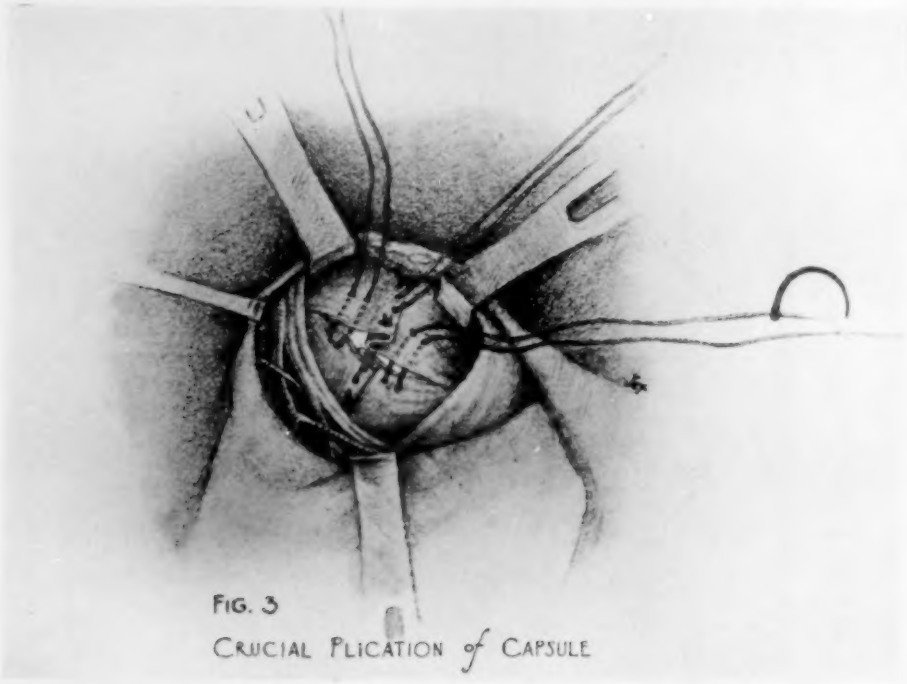

FIG. 3.—Crucial plication of capsule.

tion of chronic recurrent dislocations are also of the anterior type and are amenable to treatment by this operation.

The crucial capsular plication advocated by the writer produces a crucial band at the point of greatest weakness in the capsule and uniform capsular contraction to a degree that is not possible when the old method of vertical plication alone is resorted to. The transverse part of the plication shortens the capsule and overcomes the dropping of the head in a large proportion of cases where there is no impediment to its ascent.

Mutilating operations, as the Clairmont, should be limited to such cases as are seen in epileptics and a small percentage of others. Until authors agree as to the real etiological factors and classification based on pathology, a great proportion of cases of habitual recurrent dislocation of the shoulder-joint can be relieved by this simple operation on the capsule.

CASE RECORDS

CASE I.—M. F. (6053492), private, 34th Infantry, age twenty years, white. Home address, Lynchburg, Va., admitted W.R.G.H., December 7, 1921. History of recurrent dislocation right shoulder following accidental collision with another player while playing football in November, 1920. Spontaneous reduction.

Frequent dislocations since that time which patient can readily reduce. December 15, 1921, crucial plication of capsule with chromic gut through posterior axillary incision. Rubber tissue drain.

Uneventful recovery and patient returned to duty March 29, 1922. Cured.

CASE II.—Y. J. M., captain, engineers, aged twenty-five years, admitted October 4, 1921. Dislocation of shoulder, right, recurrent; original dislocation December, 1917, when thrown from a horse; history of five subsequent dislocations; X-ray negative for pathology.

November 1, 1921. Crucial plication of capsule through incision posterior to axillary vessels.

Uneventful recovery; to duty January 10, 1922. Cured.

CASE III.—W. T. W., warrant officer (station Ft. Wood, Governor's Island, N. Y.), age forty-four years; admitted June 3, 1923.

Recurrent dislocation, right shoulder, subcoracoid, reduced. First dislocation October, 1902, while loading trucks; frequent recurrence; last February, 1923.

X-ray of shoulder, negative.

X-ray of right shoulder, negative.

June 7, 1923. Crucial plication of capsule with chromic gut by posterior approach; closure of soft parts, rubber tissue drainage.

Uneventful recovery; returned to duty August 8, 1923. Cured.

CASE IV.—S. P. A., captain, infantry, admitted May 5, 1923. Age twenty-six. History of recurrent dislocation left shoulder, subarachnoid. First dislocation January, 1918, while scaling a wall during manœuvres; frequent recurrent dislocations since that time; last three weeks prior to admission. No report of X-ray.

May 5, 1923. Crucial plication of capsule through posterior axillary incision with drainage for twenty-four hours.

July 26, 1923. Left on thirty-day sick leave.

August 27, 1923. To duty; cured; no disability.

CASE V.—T. J. R. M., discharged soldier. Admitted March 5, 1923. Age twenty-four years. Gives a history of original dislocation of left shoulder, November, 1918, in motorcycle accident. Dislocation recurrent since this time. (At least one hundred and fifty times patient's statement.)

March 6, 1923. X-ray report. There is a small defect in the superior outer portion of the head of the humerus; nature of which is undetermined. Wassermann single plus.

March 12, 1923. Crucial plication by posterior axillary route with chromic gut; closure soft parts, rubber tissue drainage.

Patient discharged April 17, 1923; operation a failure and another operation advised.

CASE VI.—C. M. S., captain, infantry, age thirty years. Admitted January 31, 1923. Patient gives history of dislocation, shoulder, left, subglenoid, recurrent, reduced. First dislocated February, 1918, while boxing; repeatedly dislocated since that time. Last dislocation three days prior to admission. X-ray examination of shoulder negative.

February 15, 1923. Crucial plication of capsule. Uneventful recovery; practically full range of motion left shoulder, March 28, 1923. To duty this date, cured.

CASE VII.—T. C. C., discharged officer. (Address, 222 Morgantown Street, Uniontown, Pa.) Age thirty-eight years. Admitted November 6, 1923.

Gives history of recurrent dislocation of left shoulder subcoracoid, following fall on shoulder while playing football in November, 1917. Frequent recurrences. Last recurrence four weeks ago.

X-ray of left shoulder negative.

November 19, 1923. Crucial plication of capsule by posterior axillary route.

December 14, 1923. Patient discharged by request as he desires to return to work; abduction limited to 45 degrees; arm feels better since using it and having physiotherapy. Discharged this date; cured.

CASE VIII.—M. J., discharged soldier. Age not given. Admitted to N. P. service for observation for nervous and mental disease.

Transferred to Orthopædic Section for operation August 7, 1923.

Patient gives history of recurrent dislocation. No statement as to origin of same, etc.

X-ray examination of shoulder shows no pathology.

August 14, 1923. Crucial plication of capsule, left shoulder, posterior axillary route.

Patient difficult to treat due to nervous symptoms; resisted manipulation, etc.

October 5, 1923. Excellent result following capsule plication; abducts to 90 degrees; wound healed; cured.

October 8, 1923. Transferred back to N. P. Section for further treatment for mental condition.

CASE IX.—N. H. A., discharged soldier. Admitted March 19, 1923. Age thirty-five years. History of recurrent dislocation March, 1918, following a fall, at which time patient struck his shoulder on a box, causing a dislocation. Since this date left shoulder has become dislocated about twice a month (patient's statement).

March 22, 1923. X-ray examination shows no pathology.

April 23, 1923. Crucial plication posterior axillary route; drainage.

June 1, 1923. Patient discharged cured. No disability.

CASE X.—M. M., private, infantry, age twenty-two years, white. Admitted September 12, 1924.

Left shoulder first dislocated May 30, 1923, while patient was boxing. Reduced and bandaged for one week. Has been dislocated ten times since. Patient was operated October 15, 1923, at Canal Zone, capsulorrhaphy performed at this time. Has been dislocated three times since that date, last time about six weeks prior to admission.

On admission patient complains of pain in left shoulder extending down to arm to elbow and weakness in arm.

X-ray of left shoulder negative.

June 10, 1924. Operation. Crucial plication of capsule through posterior axillary approach.

June 24, 1924. Arm has been dressed daily; completely healed this date.

July 12, 1924. Physiotherapy started.

September 24, 1924. Returned from furlough. Good function in left shoulder; slight limitation in shoulder movement upward.

October 1, 1924. Discharged, to duty. Apparently cured.

CASE XI.—S. J., discharged soldier, white, age thirty-two years. Admitted May 27, 1924.

History: First dislocation December, 1915, while taking physical exercise, shoulder (left) was thrown out of place; history of numerous dislocations since that time; complains of some pain in shoulder, radiating down arm.

X-ray examination (No. 23834) June 3, 1924. The left shoulder-joint is negative.

June 16, 1924. Crucial plication through posterior axillary route with chromic gut.

July 10, 1924. Arm has been held to side of head by Balfour dressing for three weeks; arm let down this date and patient encouraged to use same.

July 22, 1924. Some falling of the head of the humerus in the glenoid still persists. Patient is able to abduct arm to nearly 90 degrees from body.

July 24, 1924. Patient discharged this date; apparently cured.

SURGERY OF JUXTA-PYLORIC ULCER

REPORT OF OPERATIVE RESULTS OBTAINED AT THE U. S. NAVAL HOSPITAL OF BROOKLYN, N.Y.

By George F. Cottle, M.D.
Lieutenant Commander, M.C., U.S. Navy

The Regulations of the United States Navy, signed by the President of the United States, charge the Bureau of Medicine and Surgery to "Use all such devices or procedures as may be developed in the science of medicine and surgery which will in any way tend to increase its military efficiency." The Naval Surgeon, as the representative of the Bureau, often finds himself confronted with difficult situations in his endeavor to solve the problems placed upon him by this regulation. The peculiar and diversified character of his duties bring him problems that touch upon every specialty of medicine, surgery and hygiene. This diversity of professional work, while highly stimulating and interesting, removes the Naval Surgeon from the field of research and experimentation, making him a follower, rather than an originator. It is necessary for him to be alive to the progress of medical science and to be ready to take up and apply so far as practicable, new procedures and devices that have become accepted by the medical profession. When the profession at large has definitely adopted a certain procedure or device the Naval Surgeon has but to follow. When, however, there is disagreement between his colleagues in civil practice as to what constitutes standard practice, he finds himself often puzzled as to the exact manner in which his duty shall be performed.

For many years the discussion between the internist and the surgeon as to the relative value of the medical or the surgical treatment of juxta-pyloric ulcer has waxed and waned. Even to-day, two schools of thought exist, the medical and the surgical. Even among the surgeons who advocate surgical care, complete agreement as to what operation is indicated in these cases seems to be lacking. One never attends a surgical meeting where these matters are discussed without hearing one man defend one type of procedure and another man defend some other. Finisterer emphasizes the removal of the ulcer-bearing area by partial or complete gastrectomy. W. J. Mayo insists that gastro-enterostomy is the operation of choice. Judd talks of excision alone or combined with other operations. Finney insists upon pyloroplasty. All claim about the same results. The surgical service of the Naval Hospital, Brooklyn, New York, has given a good deal of study to these differences of opinion and has endeavored to follow what is believed to be sound practice in the care of it's ulcer cases. In this paper the results of a year's work are reported.

A little less than one-half of the admissions to this hospital are beneficiaries of the United States Veterans' Bureau and a little more than one-half are drawn from the active and retired personnel of the United States Navy. During a calendar year three thousand seven hundred and sixty-nine (3769) patients were admitted for all causes. Of these, eighty-one (81) were diagnosed ulcer of the stomach or duodenum. During the year September to October, 1923 to 1924, the upper abdomen was explored for ulcer in seventeen (17) cases. In fourteen (14) of these ulcer was found, in one an

FIG. 1.—Benign tumor. Large filling defect pyloris.

ulcerating benign tumor was present and in the other two, no ulcers were demonstrated.

The two cases of perforated duodenal ulcer were easily diagnosed and their surgical treatment simple. They followed the clean-cut clinical course so well known. Sudden, severe, upper abdominal pain, shock, rapid pulse, leucocytosis, vomiting, board-like abdomen, absence of liver dullness. In the first case operation was performed within seven hours of the onset.

Under ether anæsthesia the ulcer was infolded and closure without drainage resulted in recovery from the emergency. The patient later was surveyed from the Navy with active pulmonary tuberculosis and reports ten months post-operation; that he still has stomach trouble and is not well. The second case, a veteran, was operated upon three hours after the onset. Under local anæsthesia the perforated ulcer was excised. He returned to his work and eight months post-operation, the follow-up reports him at work and well, except that he considers it necessary to still restrict his diet. In these two

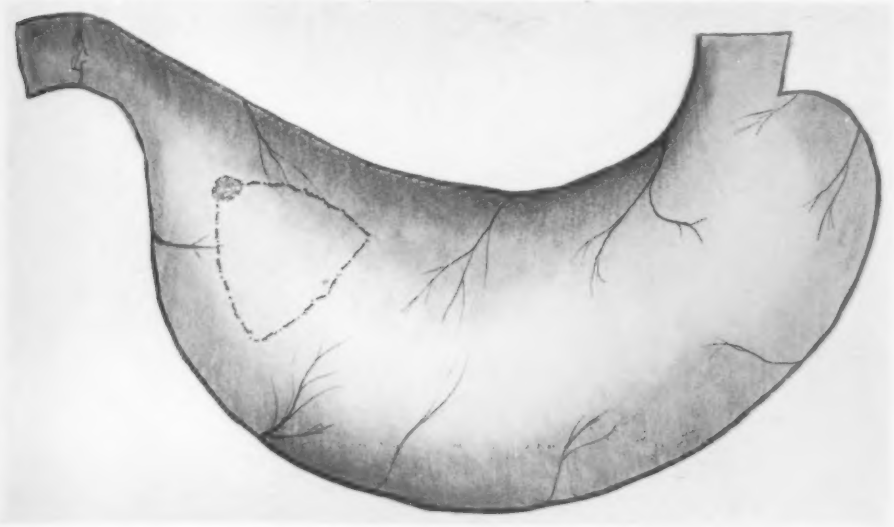

FIG. 2.—Benign tumor, diagrammatic outline.

cases, only the vital indication was met. A simple attack was made upon the perforation. Gastro-enterostomy was not performed.

Diagnostic Criteria.—The other fifteen cases were all chronic and symptoms had been present from three to seven or more years. Only when it was believed that medical treatment had been given a fair trial was operation determined upon. In the approach to these cases the usual diagnostic criteria were sought. Of these the most valuable were found to be: age, duration of symptoms, epigastric pain and tenderness, relation of pain to food, to time and to method of relief, periodicity of symptoms, vomiting, hæmatemesis and melena. The gastric analysis has given us very little positive additional assistance, although most of the cases showed a moderate hyperacidity. The study of gastric contents to indicate motility and retention was found less dependable than the fluoroscopic examination and the visualization of barium retention upon the X-ray plate. The string-test and examination for occult blood in the stool, though usually done, is not considered by the surgical service here, of much value in these cases. The X-ray proved positive or highly suggestive in every case and of course, it was the X-ray alone which gave advance information of the probable location of the suspected ulcer in the duodenum, stomach or pyloric valve region. In reaching the decision to operate, great

weight was given to the history, the physical and the X-ray findings. When all agreed, operation was deemed advisable. In one case the history did not support the diagnosis because it was the history of an alcoholic gastritis, and yet, ulcer was found. In two cases the history and X-ray were indefinite rather than positive, and in these two cases operation failed to reveal an ulcer.

Operative Risk.—The industrial status of the patient was in all cases given careful consideration. The patient was told the advantages of the medical and surgical treatment and in two cases the patients decided once more to delay

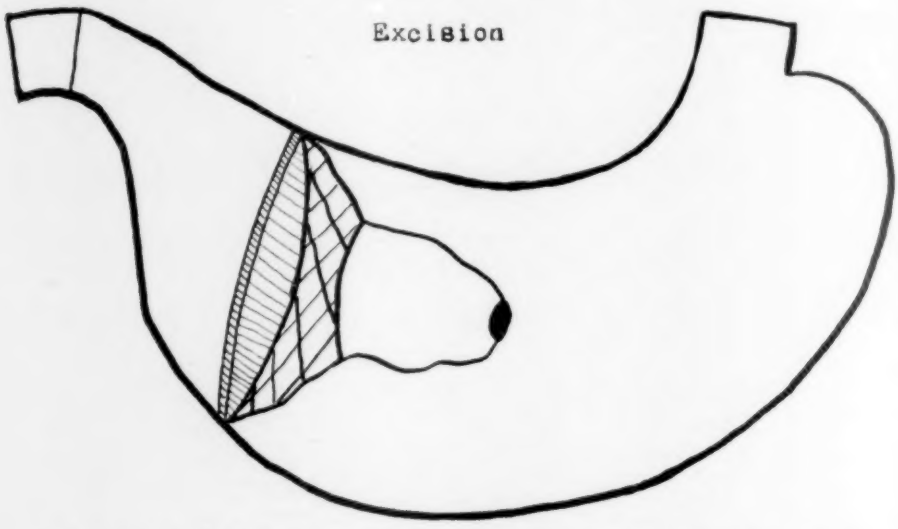

FIG. 3.—Case IX. Benign tumor. Operation—gastrotomy and excision. Diagrammatic outline.

surgical treatment and again try a return to work. However, they came back for operation. Operation was not urged in any case. It was left to the choice of the individual to elect surgical treatment. In each case, prior to operation, the operative risk was carefully considered. These ulcer patients were by no means all good operative risks. Not a few of them had other pathology recognized prior to operation. Four of them had quiescent pulmonary tuberculosis, one a reactivated pulmonary tuberculosis, and one had an active tuberculosis at the time of operation. Three had splanchnoptosis, one mild epilepsy, three well-marked psychoneuroses, one was a chronic arthritic. Most of these patients had lost weight from ten pounds up, the greatest weight lost being fifty pounds. Clinical evidence of pyloric stenosis and overnight food retention was found in only one case, and in this patient marked dehydration due to stenosis was present. Anæmia existed in all, but not severe, the lowest hæmoglobin recorded being 70 per cent. Many had foci of infection in the teeth. None were considered bad operative risks, some were fair operative risks, some good, and a few poor.

Chronic Duodenal Ulcer (8 cases).—Only one of the eight cases of duodenal ulcer had definite pyloric obstruction. This case had a twenty-four-hour

barium retention, thirty-pound weight loss, hæmoglobin of 70 per cent., bad teeth and he was considered a poor operative risk. The calloused ulcer found at the pylorus was not disturbed at operation. Posterior gastro-enterostomy brought about a definite cure of symptoms. This case gave a history of vomiting and it was the only case of the duodenal ulcer group in which vomiting was a definite feature of the history. Not one of the duodenal ulcer cases gave a history of melena or hæmatemesis. All but one showed a definite six-hour barium retention. Excision of the ulcer and appendectomy without gastro-

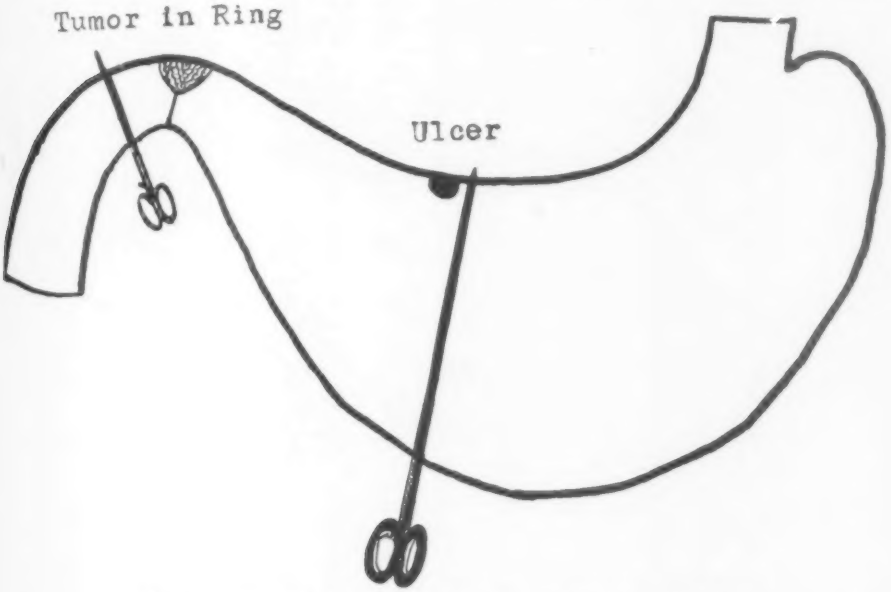

FIG. 4.—Diagrammatic outline of Case XIV. For operation see Fig. 5.

enterostomy seems to have placed seven of the eight patients in the same category of the cured or markedly improved that gastro-enterostomy did the first case. Nearly a year has passed since most of this group were operated upon and the follow-up letters received do not as yet cause the surgical service of this hospital to feel that a mistake was made in closing seven of these cases without gastro-enterostomy.

Gastric Ulcer (4 cases).—In the gastric ulcer cases vomiting was a definite feature in the history. One gave a history suggestive of hæmatemesis. In these gastric cases food relief was less definite in time and degree. The symptoms did not come and go with the periodicity found in the duodenal ulcer cases. For these cases the X-ray was positive in three and suggestive in one. Hyperacidity was not as constantly present. Definite relief from medical treatment had not as regularly occurred. Two showed a barium retention at seventy-eight hours, one at six hours and one no barium retention. At operation a more complicated pathology was found in the gastric cases than in the duodenal. The gastric ulcers were larger, they were of the callous

variety, there was in all these peri-gastric adhesions and two of them were definitely of the chronic, perforative variety. The operations performed differed in each case and were much more technically difficult than in the duodenal cases. All left the hospital apparently cured, although sufficient time has not yet elapsed to be certain of the permanency or completeness of the apparent cure.

Gastric Tumor, Benign, Fibromyoma.—One case in this series of seventeen stands out as being quite rare. The patient, a comparatively young man, on

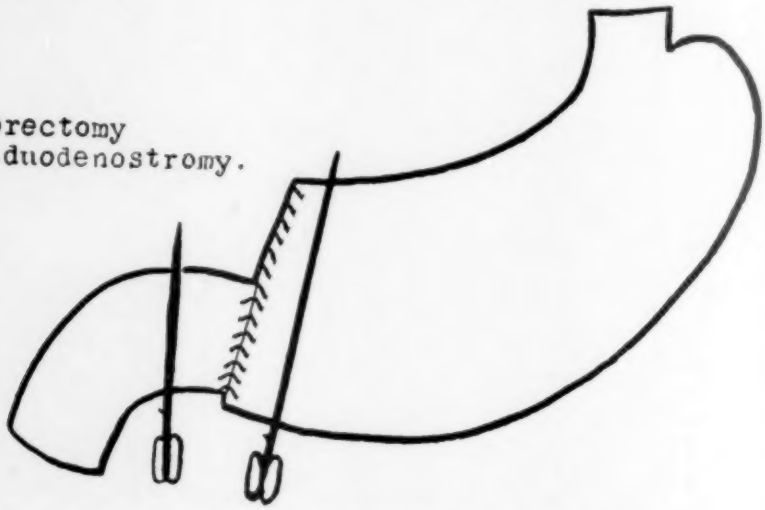

FIG. 5.—Diagram of procedure adopted in Case XIV. Billroth's 1st method.

two occasions prior to admission, had been almost completely exsanguinated by the sudden onset of hæmatemesis. He gave a history suggestive of ulcer but not positive for ulcer. The X-ray showed a large filling defect in the pyloric region which prior to operation was diagnosed as a benign tumor by the X-ray Department. At operation the cause of the violent hemorrhages was shown to be an ulcer at the apex of a pedunculated fibromyoma which grew from the anterior stomach wall into the stomach and which lay there apparently acting as a ball-valve when peristaltic motion brought the tumor against the pyloric ring. (Figs. 2 and 3.) This tumor was about the size of a small pullet's egg. It was removed by excising a narrow strip of the stomach wall which formed its base. Gastro-enterostomy was not done. No other pathology was found. The result in this case has not been satisfactory. The patient is now in the hospital again, ten months after the operation, complaining of stomach trouble, loss of weight, nervousness and constipation. A recent X-ray examination shows no obstruction. While there are many good reasons for believing this patient's present trouble is due to a marked neurasthenia which is present, the fact remains that following an operation for bleeding and for stomach trouble he is relieved of the bleeding but not of all the stomach trouble, so that for the present this case cannot be considered a surgical success.

The Non-ulcer Cases.—In the two cases in which ulcer was not demonstrated at operation, the history was not corroborative of ulcer. The pain was not in a definite fixed position. Food relief, time relief and relief from treatment were not definite. In both there were sub- rather than hyper-acidity. Both showed splanchnoptosis, one was fifty pounds below weight and suffering from a definite neurosis with marked symptoms of mental depression. Both these cases had a six-hour barium retention and both patients after being told that the operation was considered merely in the nature of an exploration, con-

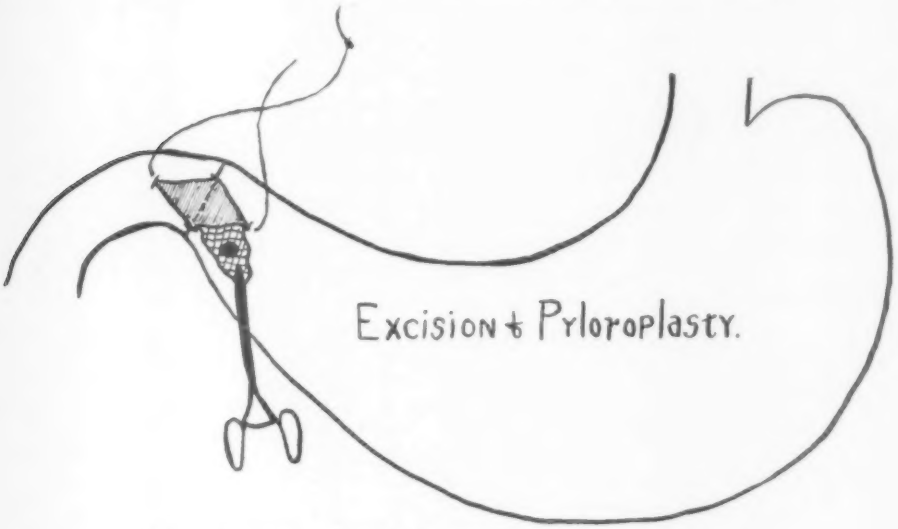

FIG. 6.—Diagram of procedure in Case IX. Ulcer involving sphincter.

sented to operation on this doubtful ground. The operation performed is herein called pyloroplasty. It consisted merely of a cutting through the duodenum, stomach and pyloric ring after thorough exploration of the abdominal viscera had failed to reveal any ulcer or other pathology. In these cases this operative procedure was determined upon for two reasons: first, because palpation of the pyloric rings indicated partial stenosis and thickening as a possible explanation of the barium retention, and second, because this incision would give a view of the mucosa of the duodenum and stomach near the pylorus, where it was thought ulcers might be found on the posterior wall. This incision, while made parallel to the long axis of the gut, was sutured at right angles to the axis. This enlarged the pyloric ring. As a method of operation, even in these patients, this procedure is not believed to be entirely defensible. However, one of these patients returned a few months after being operated upon to be operated upon for double inguinal hernia. He had gained forty pounds and had a cheerful attitude toward life, which was in marked contrast to the melancholy state he presented prior to operation. The other case left the hospital insisting that his pain was gone and most grateful for what had been done.

Anæsthetic.—The surgical service of this hospital is definitely of the opinion that at least in this hospital at this time, and with the present surgical staff, local anæsthesia is a most important assistant in this type of surgery. In every case the anæsthetic of choice was local. Splanchnic anæsthesia has not been used because of a lack of sufficient familiarity with its technic. Infiltration anæsthesia from beginning to end of the operation was successfully used in three cases. In four it was necessary to help out the local anæsthesia by the use of a small amount of ether. In ten straight ether or gas oxygen-ether was used from beginning to end. Perhaps the greatest advantage to the patient from local anæsthesia, especially here, is due to the fact that under local anæsthesia the surgeon can be more deliberate in his decisions after the abdomen is opened and take more pains, care, and time in the performance of the operation than would be safe under general anæsthesia.

Post-operative Complications.—Two cases had post-operative complications. One developed a bronchial pneumonia of brief duration, another ran a prolonged high temperature due to the reactivation of a chronic pulmonary tuberculosis. Both these cases had ether without local infiltration.

The Operations Performed

Duodenal Ulcer, acute perforation.		
Infolding	1	
Excision of ulcer	1	
Total		2
Duodenal Ulcer, chronic.		
Excision of ulcer	2	
Excision and appendectomy	4	
Excision and pyloroplasty	1	
Gastro-enterostomy, posterior	1	
Total		8
Gastric Ulcer.		
V Excision	1	
Cautery excision, Balfour gastro-enterostomy and appendectomy	1	
Pylorectomy, with gastro-duodenostomy Billroth's 1st method	1	
Partial gastrectomy with trans-colic gastro-jejunostomy	1	
Total		4
Benign Tumor.		
Gastrotomy and excision of tumor		1
Non-ulcer Cases.		
Pyloroplasty	1	
Pyloroplasty and appendectomy	1	
Total		2
Total		17

Results.—In this series there were no deaths. In all, the immediate results were excellent. They left the hospital with a weight equal to or greater than the ante-operative weight. All have been carefully followed up by letter and some have returned to the hospital in person. Sufficient time has not elapsed to determine whether these cases are cured or only temporarily relieved. The follow-up reports received, however, would indicate that most of them consider themselves markedly benefited since surgical treatment and more benefited than at any of the times when medical treatment had been used. The two cases

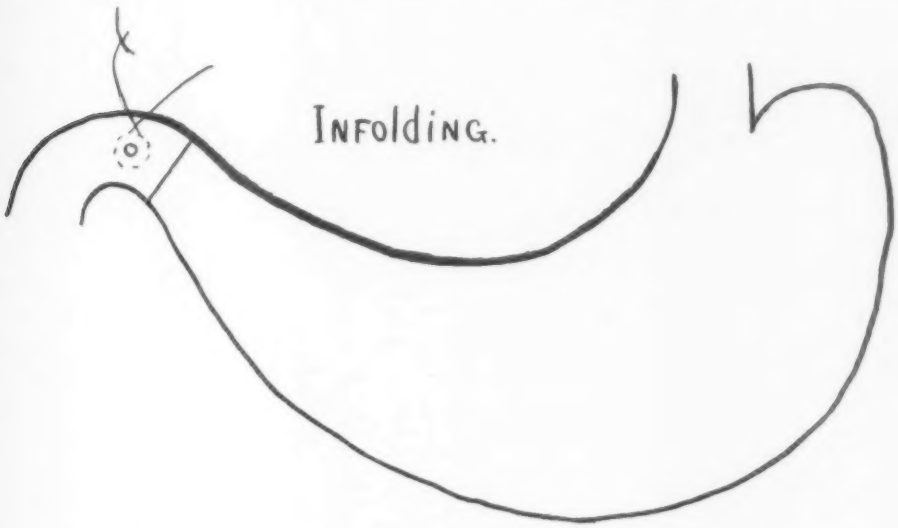

FIG. 7.—Diagram of procedure in Case I. Closure for acute perforation.

which are known to have unsatisfactory results are first, the one in which an acute perforated duodenal ulcer was infolded, the other, the one in which the benign tumor was removed. In both these cases the vital indication, death from peritonitis, death from hemorrhage, seems to have been definitely met, but both still complain of stomach trouble, the first having active pulmonary tuberculosis and the second a neurasthenia.

Ante- and Post-operative Care.—In the ante-operative preparation scrubbing the teeth and lavage of the stomach are stressed as of importance the morning of operation. After operation water is begun at the end of twenty-four hours in very small teaspoonful doses, repeated hourly, very gradually increasing the amount and decreasing the frequency. It is believed that the operated stomach and duodenum will tolerate very well small doses, frequently given and that the patient is better off to be fed quite soon after the operation is finished. If vomiting occurs, feeding is immediately stopped and lavage instituted. In none of this group of seventeen cases was it necessary to stop the feeding when once begun. Soft diet was reached by the tenth day. Upon discharge from the hospital these patients were instructed to have any remaining careous or suspicious teeth attended to and they were given instruc-

tions in what is believed to be the best sort of diet for them. They are not told that a special diet is not necessary, they are told merely to follow the usual rules of hygiene in diet. They are instructed in the use of foods that are bland, non-irritating and well-cooked and they are advised to avoid highly-seasoned, greasy, fried and acid foods. Excessive smoking is advised against and alcohol is forbidden.

SUMMARY

In the year at the Naval Hospital, Brooklyn, N. Y., there were seventeen persons operated upon for juxta-pyloric ulcer. All but two are apparently cured. One of these two now has active pulmonary tuberculosis and the other a neurasthenia, which, if not due to stomach condition must at least be considered as possibly based upon the pathology which operation sought to cure. There were no deaths. Local anæsthesia is considered the anæsthetic of choice. Its limitations being mainly the experience of the operating surgeon in this type of anæsthesia. A surgical service operating upon this type of cases must carefully follow its cases post-operative in order to know whether its patients have been properly operated upon or not. If the patient is not well after surgery has been instituted, the surgeon should not blame the patient for failing to carry out some complicated form of diet or medical treatment, but he should accept that failure as his own. It is my belief that a surgical cure of these cases should not be claimed unless the patient is relieved of pain and is sufficiently well to return to a gainful occupation on a reasonably unrestricted diet.

ABSTRACT OF CASE HISTORIES

Case I.—Hospital Number F. 33903, M. G. F., age twenty-three years. Perforated duodenal ulcer. Indigestion for three months. Entered hospital in shock, pulse 120, cyanotic abdomen board-like scaphoid. Liver dullness absent, stating he had vomited and that the sudden severe terrible pain in epigastrium had begun seven hours before. White blood cells 19,600, polymorphonuclears 91.

Operation December 9, 1923, ether anæsthesia, perforated duodenal ulcer infolded, toilet of peritoneum, closure without drainage. Recovery good but was later surveyed from United States Navy for reactivated pulmonary tuberculosis.

One year after operation still has indigestion and is in a tuberculosis sanitarium.

Case II.—Hospital Number F. 00683, M. T., age thirty years. Perforated duodenal ulcer. Entered hospital stating that three hours before while at work he had been seized with a terrible epigastric pain which had persisted in severity without relief. He had vomited. Abdomen was rigid all over, liver dullness was not present. Pulse 136, white blood cells 19,500, polymorphonuclears 68 per cent.

Operation February 29, 1924, local anæsthesia. A perforated duodenal ulcer was excised, the peritoneum cleaned and abdomen closed without drainage.

Ten months post-operative he reports himself at work and quite well. He still feels a restricted diet is necessary.

Case III.—Hospital Number F. 02670, J. E. S., age thirty-five years. *Stenosis from pyloric ulcer.* Duration of symptoms five years. Pain in epigastrium one hour after eating, food relief. Periodicity of symptoms present. Thirty pound weight loss. Tender in epigastrium. Vomiting was an important and definite feature which was

becoming more frequent. Hyper-acidity. Positive X-ray twenty-four-hour barium retention, pyloric obstruction diagnosed ante-operation. Sippy diet had often benefited. Hæmoglobin 70 per cent., quiescent pulmonary tuberculosis present, bad teeth. Operative risk poor.

Operation November 7, 1923, local and ether anæsthesia. Posterior short loop gastro-enterostomy. Calloused ulcer obstructing pyloric outlet not disturbed.

One year post-operative reports weight gain of 32 pounds, eats anything and believes himself cured.

Case IV.—Hospital Number F. 32723, J. A., age thirty-four years. Duration of

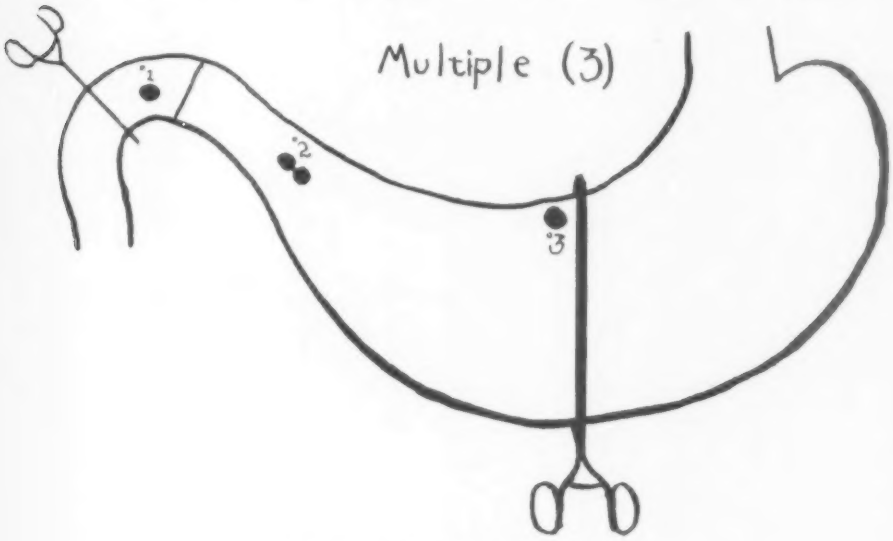

Fig. 8.—Case XV. Multiple ulcers.

symptoms five years. Pain in epigastrium one-half hour after eating, relieved by food. Periodicity of symptoms definite. Weight loss 32 pounds. He had vomited occasionally. Hyper-acidity. A positive X-ray with six-hour barium retention. He had previously been benefited by Sippy diet. He was in vocational training. He had an inactive tuberculosis. Splanchnoptosis and hæmoglobin 90 per cent. Operative risk estimated poor.

Operation September 12, 1923, ether anæsthesia, excision of duodenal ulcer. Post-operative complication, broncho-pneumonia.

Left hospital stating pain was gone and follow-up five months later and one year later reported gain of weight of 40 pounds, that he is at work, eats everything and he feels that he has completely recovered.

Case V.—Hospital Number F. 30842, M. J. C., age thirty-two years. Duration of symptoms seven years. Pains in epigastrium one hour after eating, relieved by food. Periodicity of symptoms not definitely present. Epigastric tenderness, at present. X-ray positive for six-hour barium retention. Sippy diet had been of benefit. Had lost ten pounds in weight. He had X-ray evidence of pulmonary tuberculosis which seemed clinically quiescent. Hæmoglobin 80 per cent. Operative risk considered fair.

Operation October 9, 1923, ether anæsthesia. Excision of duodenal ulcer.

He left the hospital and returned to full duty aboard a naval vessel and the follow-up one year post-operative reports him still on the job at sea.

Case VI.—Hospital Number F. 00080, D. H. M., age twenty-nine years. Duration of symptoms five years. Pain epigastric, two to three hours after eating, food relief.

Periodicity of symptoms present. Epigastric tenderness. Hyper-acidity. Positive X-ray and six-hour barium retention. He had been benefited by Lenhartz treatment. Hæmoglobin 90 per cent. Operative risk good.

Operation January 28, 1924, ether anæsthesia. Excision of duodenal ulcer and appendectomy.

Three months after leaving hospital he reported original weight regained, feels well and is back at work.

Case VII.—Hospital Number F. 33659, J. J. F., age thirty years. Duration of symptoms three years. Pain epigastric two hours after eating, relieved by food and

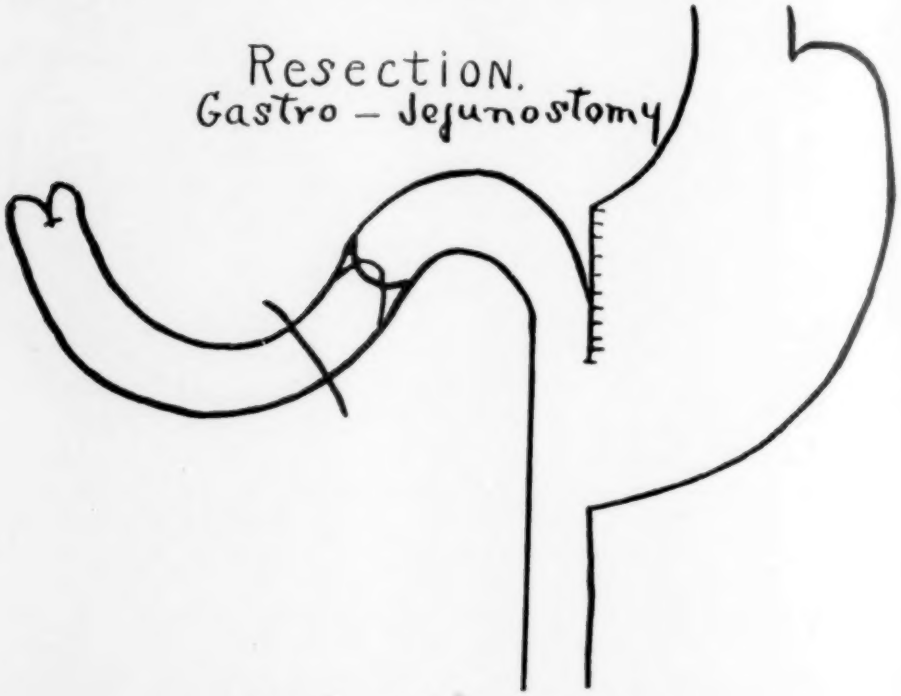

Fig. 9.—Case XV. Operation—partial excision.

alkalies. Periodicity definite. Epigastric tenderness was recorded. Hyper-acidity. Positive X-ray and six-hour barium retention. Sippy treatment had given relief. Hæmoglobin 85 per cent., no complicating conditions. Operative risk good.

Operation February 15, 1924, ether anæsthesia. Excision of duodenal ulcer and appendectomy.

Left hospital with a gain of two pounds over ante-operative weight. No follow-up report received.

Case VIII.—Hospital Number F. 00364, M. D. H., age twenty-seven years. Duration of symptoms four years. Pain epigastric two to three hours after eating, relieved by food. Periodicity of symptoms present. Epigastric tenderness. Positive X-ray and six-hour barium retention. Milk diet had been of benefit. Hæmoglobin 85 per cent. Fair operative risk.

Operation February 20, 1924, ether anæsthesia. Excision of duodenal ulcer and appendectomy.

He left the hospital with an ante-operative weight gain of two pounds and reports seven months post-operative, well and back at work.

Case IX.—Hospital Number F. 33829, J. C. P., age thirty-five years. Duration of symptoms eighteen years. Pain epigastric one hour after meals, relieved by food. Periodicity present. Ten pound weight loss. Tenderness in epigastrium. Hyperacidity. Positive X-ray with a six-hour barium retention. Sippy diet had brought relief many times. Hæmoglobin 90 per cent. Patient was an alcoholic. Operative risk fair.

Operation March 5, 1924, local anæsthesia. Excision of duodenal ulcer and pyloroplasty.

Follow up six months post-operative reports him able to work.

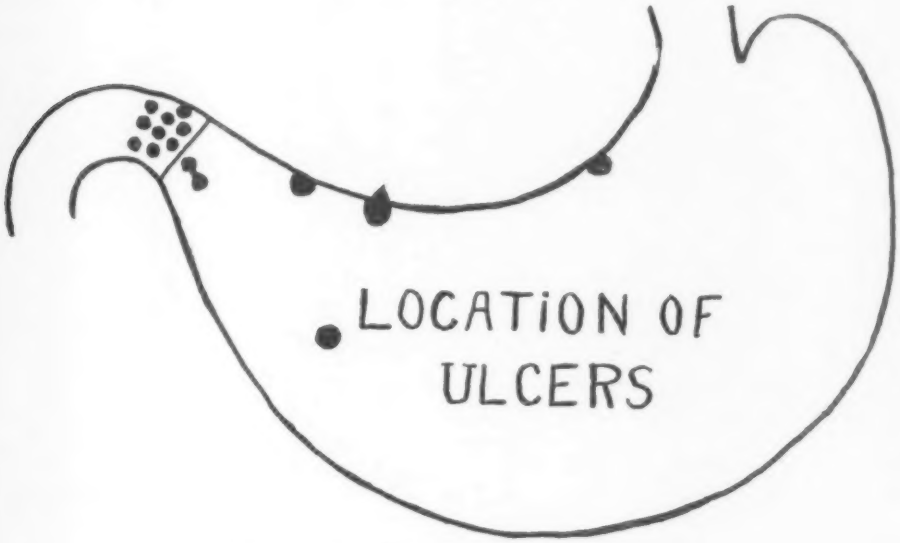

Fig. 10.—Cases I to XV inclusive, except Case XI.

Case X.—Hospital Number F. 01064, M. J. O., age twenty-eight years. Duration of symptoms five years. Pain epigastric one-half hour after meals, relieved by food. Periodicity present. He had lost twenty pounds. Tenderness in epigastrium. Acidity below normal. X-ray positive and no barium retention. Sippy diet had benefited. Hæmoglobin 90 per cent. Bad teeth. Good operative risk.

Operation April 9, 1924. Excision of duodenal ulcer and appendectomy.

Left hospital six pounds over ante-operative weight and five months post-operative finds him well and back at his work.

Case XI.—Hospital Number 33335, T. F. L., age thirty-two years. Duration of stomach trouble five years. Pain, epigastric one hour after eating, food relief. Periodicity present. No weight loss. On two occasions had been nearly exsanguinated by violent hæmatemesis and melena. Acidity normal. X-ray Plate No. 1, reported a large filling defect near pylorus probably a benign tumor. Sippy diet had benefited. Hæmoglobin 80 per cent. Red blood cells 3,200,000. He was very nervous and high strung but otherwise considered a good operative risk.

Operation December 19, 1923, local anæsthesia. Tumor size small pullet's egg, fibromyoma removed from anterior stomach wall, Plate No. 2. At apex of tumor there was an ulcer.

One year after operation still has stomach trouble and obst'nate constipation. X-ray of stomach shows no obstruction.

Case XII.—Hospital Number 02496, J. A. M., age twenty-seven years. Admitted July 14, 1924, diagnosed ulcer of stomach. Duration five years. Slight pain relieved

by soda and occasionally by food, tenderness. Vomiting frequently increasing during past six months. Heart presystolic murmur. Teeth four crowns. Weight loss twenty-one pounds. Hæmoglobin 90 per cent. Complication, occasional rare epileptic attacks. Gastric analysis, retention of raisins. Acidity normal. X-ray seventy-eight-hour retention. Pyloric ulcer present.

Operation August, 7, 1924. Local and general anæsthesia. V resection lesser curve and anterior and posterior walls. Pathology found chronic perforated ulcer ¼ x 1 inch lesser curve 1½ inches from pyloric ring.

Left hospital free of a pain, no stomach symptoms, pre-operative weight regained.

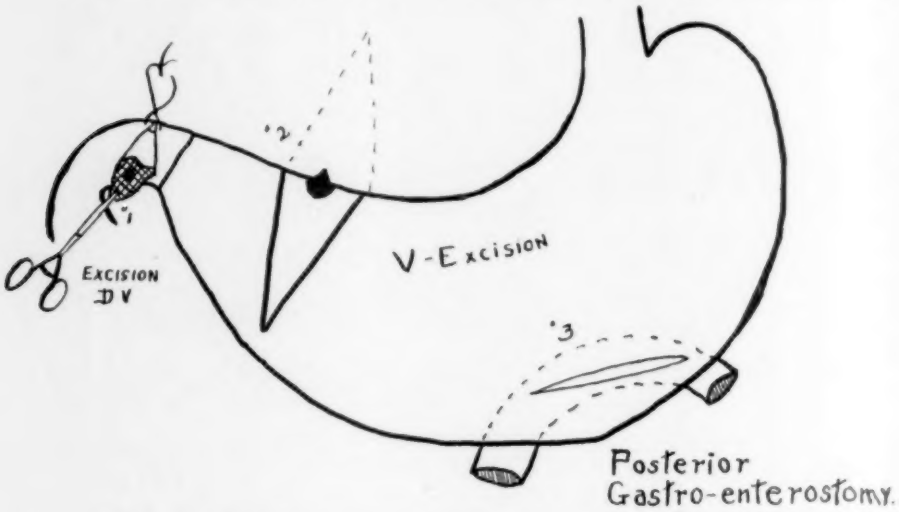

FIG. 11.—1° Cases II, IV, V, VI, VII, VIII, X. 2° Case XII. 3° Cases III, XIII.

October 20, 1924, returned complaining of pain. Observation and X-ray showed normal condition. Returned to work.

CASE XIII.—Hospital Number F. 00594, C. H. K., age thirty-six years. Admitted September 30, 1924, diagnosis duodenal ulcer. For six years has been subject to attacks of pain coming one and one-half to two hours after meals, worse in spring and fall increasing gradually in frequency and in duration. Relieved by heat, rest and vomiting worse on empty stomach. Slight pains at times, upper abdomen both sides. Loss of weight twenty pounds. Teeth pyorrhœa and crowns. Systolic murmurs at apex over mitral area. Pulse 84. Tenderness gall-bladder. X-ray and clinical evidence of old fibrotic changes in lungs. X-ray suggestive for ulcer. Positive for chronic appendicitis. Hæmoglobin 75 per cent. Gastric analysis, slightly hyperacid.

Operation October 23, 1924, appendectomy, cautery or positive excision chronic perforative large ½ inch calloused ulcer wall about 2 inches from pyloric ring. Gastro-enterostomy posterior short loop.

October 29, 1924. Condition satisfactory, still in hospital, pain gone.

CASE XIV.—Hospital Number F. 02549, J. C., age forty-five years. Admitted July 14, 1924, diagnosis undetermined and was intoxicated upon arrival. Pain in stomach, vomiting. Duration of symptoms six years. History good for alcoholic gastritis. Clinical and X-ray positive for chronic pthisis. Irregularity of pulse and heart sounds muffled. Gastric analysis, sub-acidity. Hæmoglobin 80 per cent. X-ray showed small pre-pyloric filling defect. Six-hour barium retention. Complicating conditions: psychoneurosis, alcoholic, cavity in lung quiescent, compensation complete.

Operation August 20, 1924, pylorectomy, Billroth's first method. Pathology, hard fibrous nodule at pyloric ring and ulcer on lesser curvature, perforative type near pylorus. Complication, reactivation of pulmonary tuberculosis.

September 30, 1924, pre-operative weight regained. No pain. Can eat any kind of food. Discharged to pulmonary sanitarium.

Case XV.—Hospital Number F. 02297, J. M., age forty-five years. Admitted June 25, 1924, diagnosis, chronic arthritis. Ex-Sergeant United States Army. For six years has had epigastric pain relieved by vomiting and soda. Slight pain in right shoulder, and lately has become more severe. Loss of weight fifty pounds. Ankle and knee chronically stiff and painful. Hæmoglobin 70 per cent. Hyperacidity. Retention of raisin skins. Tenderness present. X-ray ptosis, seventy-eight-hour gastric residue, no filling defect, pyloric ulcer.

Operation July 30, 1924, local and general anæsthesia, partial gastrectomy with trans-colic suture of stomach stump to jejunum pathology, healed ulcer duodenum, chronic perforating ulcer, lesser curvature nearer cardiac than pyloris. Pyloric stenosis and markedly thickened.

September 12, 1924, pre-operative weight regained, pain is gone and eats anything if not to great in quantity, eats five instead of three times a day. October 2, 1924, ten pounds above pre-operative weight.

Case XVII.—Hospital Number F. 02838, C. M. M., age twenty-eight years. Duration of symptoms for seven years. Pain general, abdominal, steady no periodicity. Fifty pounds weight loss. Sub-acidity X-ray suggestive of ulcer, six-hour barium retention. Sippy diet had relieved condition. There was a marked splanchnoptosis and a mental depression almost a melancholia.

Operation January 16, 1924, ether anæsthesia, pyloroplasty (type described in paper) and appendectomy. Pyloric ring was found hypertrophied and somewhat smaller in caliber than normal, believed to be pylorospasm.

Returned to hospital several months later having gained forty pounds and seemed completely recovered from his mental depression and free of pain and stomach symptoms.

Case XIII.—Hospital Number F. 02838, C. M. M., age twenty-eight years. Duration of symptoms seven years. Pains umbilical came whenever he ate anything. Periodicity present. Tenderness left epigastric, sub-acidity. X-ray suggestive of ulcer. Six-hour barium retention. Hæmoglobin 90 per cent. No weight loss. Splanchnoptosis. Operative risk excellent.

Operation September 18, 1924, ether anæsthesia. Pyloroplasty. Pyloric ring found small but not thickened.

Left hospital free of pain, eating well, normal weight and most grateful for result.

AMPUTATIONS IN INDUSTRIAL SURGERY

By William Lawrence Estes, M.D.

of Bethlehem, Pa.

A study from the clinic of St. Luke's hospital

Though the material of this paper is taken wholly from the Clinic at St. Luke's Hospital, Bethlehem, Pa., the data and conclusions are fairly representative of the work done in other hospitals whose situation and opportunities required them to function chiefly along industrial and surgical lines. The study is based upon the work done at the clinic during the period when the writer was Director and Surgeon-in-Chief of the hospital.

All cases of major amputations are included, except those which came to the hospital in hopeless conditions. Only 58 of the amputations were done for pathologic condition. Practically all of the persons operated upon had other injuries than the one which required amputation of a limb. In many instances the multiple injuries were severe ones. Many of the patients were transported long distances in order to reach the hospital and few of them had received any proper first-aid assistance. In short, a great deal of the work was done on patients who had been no less severely injured than soldiers are in military operations. The chief difference was the patients did not come in such large numbers at any one time and they received prompter individual attention after reaching the hospital.

GENERAL CONSIDERATIONS

(A) *Conditions Which May Determine the Amputation of a Limb.*—1st. In the first place the surgeon must decide whether or not the patient is in a general physical condition to withstand a major operation.

This will depend largely upon whether the person who has recently sustained multiple injuries is badly exsanguinated and is nearly exhausted. The blood-pressure will serve as a safeguard to determine whether an operation should or should not be undertaken immediately. A systolic pressure below 80 mm. of mercury means no major operations should be attempted and that the patient must not only wait, but must also have active measures employed for recuperating his strength.

In many instances patients who arrived at the hospital apparently moribund were resuscitated and brought to a condition in which major amputations were safely done and the patients made prompt recoveries.

Absolute control of all hemorrhage is the first requisite. Then the restoration of the circulating medium should be in a measure obtained; best by transfusion of blood. If this for any reason is impracticable, then by hypodermoclysis of saline and glucose solutions, by proctolysis by the drip method, giving much water by the mouth, and liquid concentrated food. Intravenous infusion of saline solutions must be done exceedingly carefully, else they will

do harm rather than good. The inclination is to give the solutions too rapidly. They must be given slowly and not in too large quantities at any one time. Morphia given hypodermically is a sheet anchor in these seriously injured cases. Adrenalin chloride solutions hypodermically also do good. Strychnia and camphor hypodermically may also assist.

2nd. The surgeon must decide whether in the individual case the injury has absolutely destroyed the extremity, or has been of such a grave nature that the extremity will be useless, or a menace to life.

The experience and teaching surgeons have received from the late war will serve to save many limbs and lives which without it would inevitably be lost. The proper use of the hypo-chloride solutions, and dakinization, are the outstanding gifts to surgery from the war.

In case of doubt one should employ conservative methods and await developments.

It is nevertheless true even now that conservative attempts in very serious injuries of limbs in doubtful cases have a higher death-rate than amputations of the limb have, and require much longer periods of disability; that is to say, before the patient is able to be out of bed and to resume some measure of activity.

In deciding for or against an amputation the surgeon should consider also: (a) The age of the patient, (b) his industrial position and the necessities for future livelihood, etc. (c) The length of the probable disqualifying disability and the patient's probable usefulness.

FIG. 1.—Stump of an amputation of the arm lower and middle third. Antero-posterior flaps. Drawn from a plaster cast of the stump.

3rd. As regards the nature and severity of the injury to the limb. (a) When a limb is entirely severed there can be, of course, no question. The consideration will be where to limit the "trimming up" so as to obtain a good useful stump.

(b) Transverse crushes of all the anatomic elements of a limb require amputations. (See Fig. 6.)

(c) Transverse lacerations of the limb, if they sever the chief blood and nervous supplies, require amputations.

Longitudinal and oblique lacerations may be extensive and yet the limb may be saved. (See Fig. 10.)

(d) Transverse crushes, such as are produced by a car wheel or a heavy steel beam running against or falling upon a limb, though the skin may appear viable, if the muscles and bones are badly crushed, require amputations. (See Figs. 8 and 9.)

Also extensive transverse destruction of the skin and subcutaneous fat and fascia, though the muscles and bones do not seem to be badly comminuted, usually require amputation.

One may by use of the Carrel-Dakin treatment postpone amputation however, in order to see how the deep tissues react. Dakin's solution liquefies clots and blood and detritus of soft tissues. Secondary hemorrhage may follow its use in cases such as these. One should always caution the nurse in charge to be on the lookout and instruct her how to meet the emergency of sudden hemorrhage in each individual case.

(d) Compound comminuted fractures where as much as three inches of bone must be lost and extensive laceration of the soft tissues has occurred about the bone, as a rule should be amputated. Though it will be well to postpone amputation in some cases and see if by secondary operation the bone may be spliced, if the blood and nerve supply prove adequate to sustain the nutrition of the extremity below the wound.

(e) Division of the chief blood-vessels of a limb in a case of compound fracture, usually requires an amputation. Though in these cases also it is well to wait, dakinize and watch the issue for a time.

Division of one or more nerve trunks may be repaired by suturing or splicing. Anastomosis of torn blood-vessels immediately or soon after a severe injury is not successful.

(f) In any given case, though it may be possible to save the limb, if one is convinced the conservative attempt though successful will leave the limb distorted and useless, it would be best to amputate.

(g) If a gas bacillus or streptococcal infection should occur in spite of the best care of a seriously injured limb, immediate amputation must be considered.

(B) *The Proper Time to Amputate.*—If the patient is not too exhausted and too weak to withstand the further effect of the operation, the proper time to amputate will be as soon after the patient has been brought into the hospital as practicable.

First by gentle and careful examination of the injured limb one should ascertain that an amputation will be necessary, then by as thorough and general examination as may be made find out whether the patient's condition of resistance and vitality indicate he will be able to go through the operation, without any serious detriment. As was said before the blood-pressure while not infallible, in most cases will prove a safeguide.

Unless some condition in the locality and nature of the injury makes it imperative to operate at once, amputations may be postponed twenty-four or forty-eight hours without much added peril to the patient, provided the wound

may be thoroughly irrigated and inundated with a Dakin's solution, and the injured member be immobilized, and especially if hemorrhage can be controlled.

Secondary amputations, in the old sense of amputation after serious and

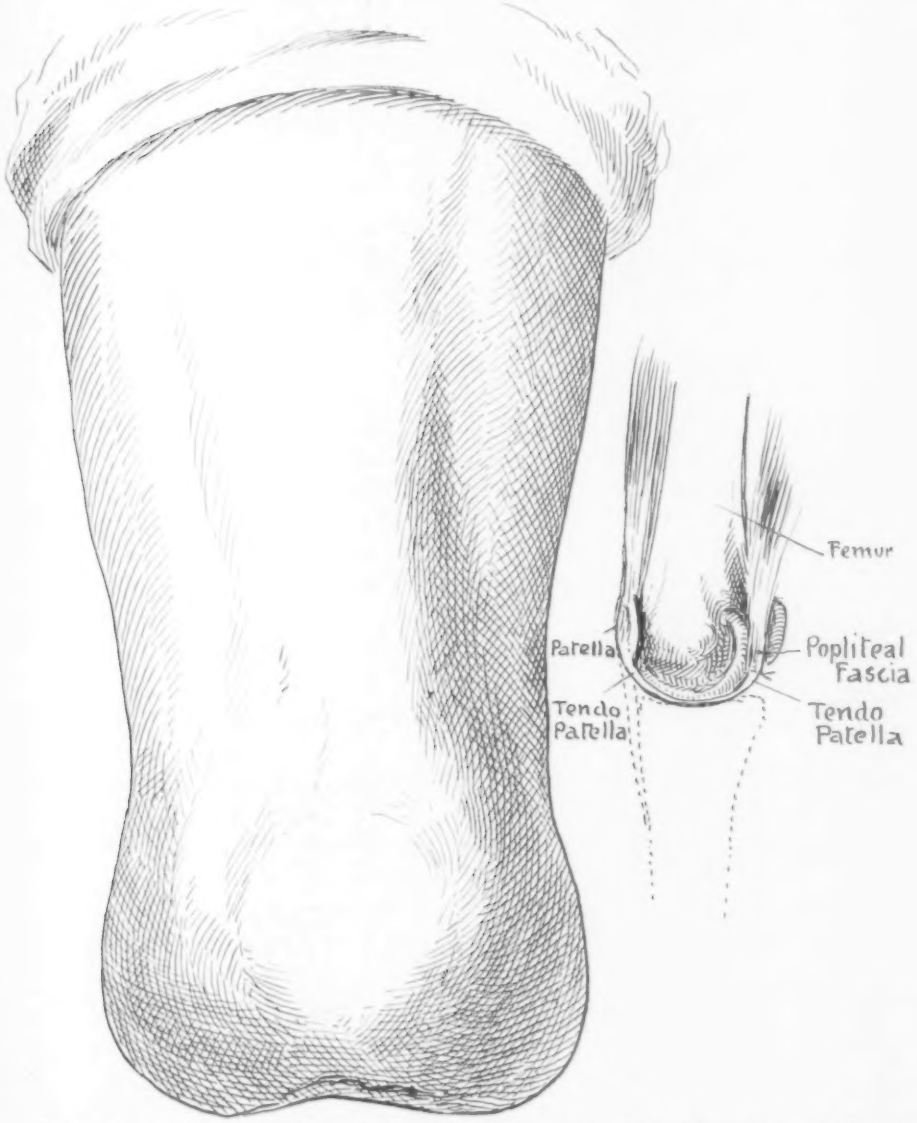

FIG. 2.—Stump of an amputation at the knee-joint. Long anterior flaps. Insert: Schematic illustration of the union of the patella tendon with the fascia of the popliteal muscle. Stump drawn from a plaster cast some time after the operation.

unsuccessful attempt to save the limb has been made, are followed by a much longer period of disability and one is usually obliged to make the stump shorter and to include diseased tissues in the stump.

Immediate or very early radical operation, too, will relieve the patient

of an incalculable amount of pain, thus cutting off the "noci association" of Crile, which may be deadly in some cases.

In all cases of delayed amputation it is absolutely necessary to control hemorrhage. Acute anæmia is usually the predominating factor in producing the exhaustion one finds so commonly in cases of seriously mutilated limbs. This is usually preceded by psychic shock, an evanescent condition, if it is not fatal at the moment of the injury or very soon after. During the psychic shock very little if any bleeding occurs. This fact is not known or forgotten by many physicians who render first aid. Not finding any hemorrhage when they see the patient immediately after the injury, they conclude no provision for the control of hemorrhage is necessary. The result is that psychic shock is, under the effect of a full dose of hypodermic morphia and warmth, so completely relieved that "reaction" takes place while the patient is being transported to the hospital and in many such cases the individual will reach the hospital already dead or in a moribund condition.

When it is determined that it is absolutely necessary to amputate an injured limb, but the condition of the patient is so low it must be delayed, the most certain, quickest and best method of assuring the control of hemorrhage is by the use of an elastic constrictor; a rubber band like an Esmarch elastic tourniquet or a Martin's rubber bandage, will be best. If the limb is not severed or is not hanging only by shreds of soft tissues, a Martin's rubber bandage applied from the foot or hand, as the case may be, all the way to, over, and just a trifle above the seat of injury will serve best. The wounded area should have been cleaned as thoroughly as practicable and as thoroughly as possible disinfected by a strong hypochlorite solution, covered by several layers of gauze wet in the hypochlorite solution, a mass dry dressing placed over this and over all the rubber bandage; this bandage should be so securely fastened that it will not come loose. When the patient shall have rallied this whole dressing, rubber bandage, gauze, etc., should remain undisturbed and the extremity above this be prepared for the operation.

If the crush of the limb has severed the tissues or left only shreds at the seat of injury, the rubber band should be applied as close as practicable above the crush, over injured tissues, but tissues having sufficient integrity to hold in the grip of the band. To prevent the band slipping down and thus releasing the blood-vessels, long sterile pins or skewers may be thrust through the injured tissues immediately below the band, or a muslin bandage may be placed under the rounds of the tourniquet, tied over them firmly and ends secured in some way, so that the tourniquet will be held firmly in place.

The rubber constrictors should never be released until the limb has been amputated. By observing this rule one avoids unnecessary manipulation of the injured member, saves time, and above all, prevents the distribution upwards of the microörganisms of infection which will have developed at the point of injury.

Placed as suggested, except through the movement made necessary in order to apply the constrictor and the disturbance this causes, the prolonged

constriction entails no additional pain as the band involves areas already so injured that their nervous supply is entirely destroyed.

(C) *Where to Amputate. Points of Selection.*—The later suggestions, which seem to be endorsed by military surgeons, of making a weight bearing end for the stumps in the lower extremities, have caused some modification of "points of election." It is generally conceded, however, that every increment of length possible should be preserved in the upper extremity. The writer endorses this with the proviso that viable flaps must be obtained. Nothing is gained by including devitalized tissues in the flaps in the attempt to preserve length of stump. This serves to increase the time of disability, adds to the suffering of the patient, and will necessitate a secondary operation. Irregular and inadequate flaps are, however, much better tolerated in the upper than in the lower extremities, unless the ends of the main nerve trunks are caught in the fibrous tissue of the cicatrix.

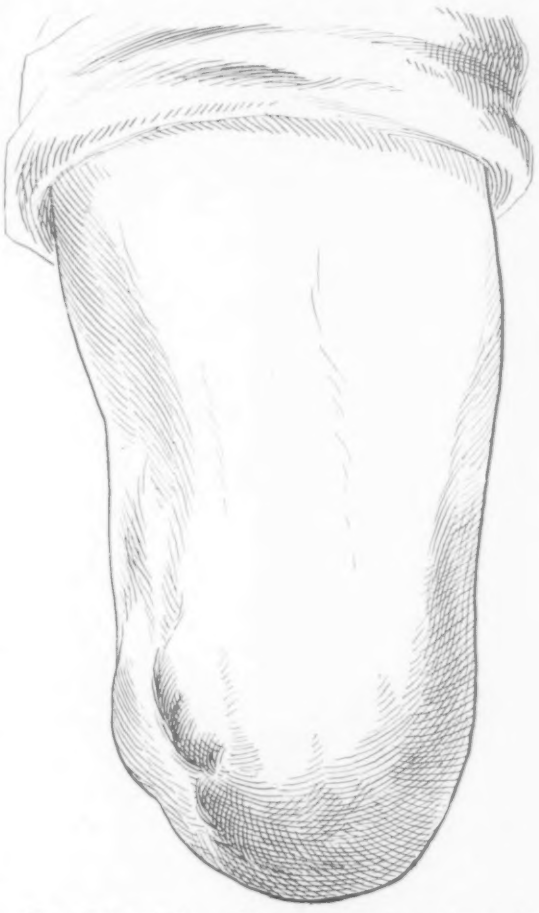

FIG. 3.—A typically useful stump of an amputation at the junction of the lower and middle third of the leg. Antero-posterior flaps. Drawn from a plaster cast of the stump.

Amputation of the lower extremities require much more consideration in regard to the point of selection. Major Norman T. Kirk, M.D., in a recent little book on Amputations, condemns all mediotarsal and tarsal amputations of the foot, and recommends that no amputations through the lower third of the leg be done. The writer, however, in reviewing his forty years' work, and after examining many of his amputations done many years ago, has found no reason to change his view that mediotarsal amputations with good adequate plantar flaps, properly sutured, furnish most useful and painless stumps and may be fitted with prosthetic appliances which permit such excellent gait that an observer would never notice the individual was not perfectly normal. Also he continues to believe the lower third of the leg is the point of election when

possible in amputating a leg. In addition to the fact that prosthetic apparatus makers in civil life find this region most adaptable for the application of a false leg, the mortality rate of amputations in the lower third is so much lower than those through the middle third of the leg that a surgeon must let this weigh heavily in favor of the lower amputation. (See tables.)

Amputations through the middle third undoubtedly furnish more soft tissue to cover the ends of the bones, but in the leg end weight bearing is not nearly as important or useful as it is in stumps of the thigh. Indeed the mechanism of the movements at the knee-joint require lateral support, rather than end bearing. No false leg could be borne long nor usefully employed unless it gripped, or the socket fitted snugly the sides of the stump and transferred the weight to the sides of the leg rather than rest it on the end of the stump.

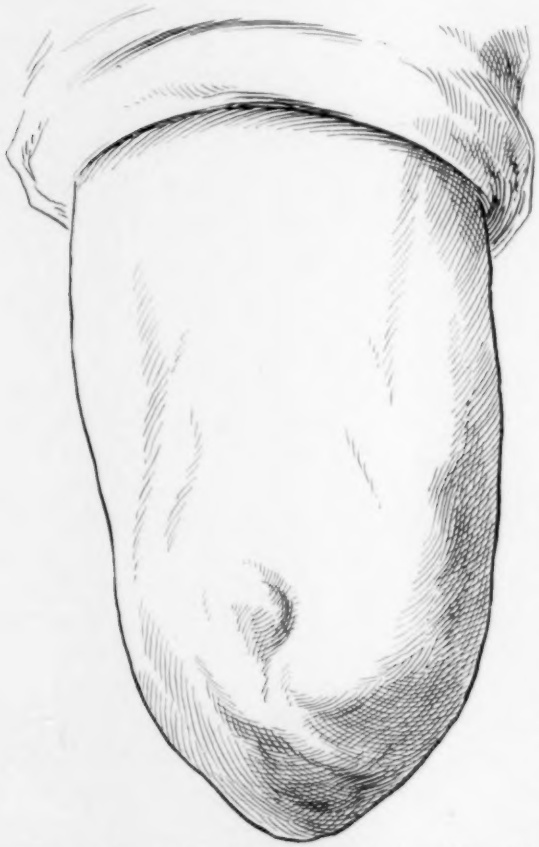

FIG. 4.—Amputation of the leg through the middle third, lateral flaps. Drawn from a plaster cast taken some time after the amputation. A painless useful stump.

No amputations of the upper third of the leg should be done unless a bone length of at least five inches may be obtained for the stump. Even then the socket of a false leg is apt to bear so heavily upon the head of the fibula, that a most painful condition will be set up. Sometimes dislocation of the head of the fibula is gradually produced; in this case the extremity of the fibula will be so distorted that an ulceration of the stump may be produced from its irregular position and constant pressure. If the condition of the limb admits only an amputation above the junction of the middle and upper third of the leg, it will be better to amputate at the knee-joint. The mortality is even less at the knee-joint than in the upper third of the leg. (See tables.)

The lower third of the thigh is the ideal region for thigh amputations. The resulting stump may be made end bearing, it gives sufficient leverage for the proper use of a false limb, and the mortality rate is comparatively low.

Amputations as high up as the middle of the thigh may furnish fairly

useful stumps, but above this region no useful stump, in the sense of furnishing proper leverage to move prosthetic appliances, can be obtained and the death-rate of amputations through the upper third of the thigh is very high. Guillotine amputation may be permissible to retain greater length of bone in a thigh—amputation with the idea of improving the stump by later secondary plastic operations.

AMPUTATION TECHNIC

1. *Preparations for Amputations and Preliminary Treatment.*—Every serious industrial injury entails more or less soiling of the wound; hence the wound will have been infected before the surgeon sees it. In many, perhaps in most injuries of a major kind, the soiling is extensive and the soil and microörganisms of the locality at which the injury occurred will have been ground into the deep tissues of the injured part. In coal mines, unless the injury occurs in or about the stables of the mules used in the mines, though the soiling seems very great, it is made up chiefly of carbonaceous matters, and, except as foreign matter in the tissues, is harmless unless the man's clothing has also been driven or pressed into the wound. In the latter case infection will result. Injuries occurring in factories will always be infected, usually staphylococcic infection. Those occurring along railroads are usually, in towns and at highway crossings they are also infected. Injuries which occur in streets and on highways are always thoroughly infected, and commonly by the tetanus bacillus as well as by the vicious microörganism of suppuration, such as the gas bacilli and the streptococci of various strains.

Preparation of the injured person for operation should, therefore, include an anti-tetanic inoculation and very careful cleansing and disinfection of the injured member.

As soon as it has been determined that an amputation will be necessary, which ought to require but very few minutes after the patient reaches the hospital, unless the patient has already had a hypodermic dose of morphia, or even if he has had morphia and shows no marked signs of its effect, a hypodermic injection containing one-quarter grain of morphia and one one-hundred-and-fiftieth of a grain of scopolamine, or hyoscine hydrobromide, should be given. Then if it already has not been done, measures for the control of hemorrhage should be taken, *viz.*, pack the wound or wounds with sterile gauze and mass dressings with a tight bandage applied over all, or an elastic tourniquet be applied. While the instruments are being sterilized and surgeons and nurses are getting into their operation room clothes, scrubbing and sterilizing their hands, etc., the patient should be allowed to rest. All this will require a half hour at least. When everything and everybody is ready for the operation and the patient's soiled clothing has been cut off and replaced by a warm clean gown, before the patient is sent from the receiving room, another hypodermic dose of morphia sulphate, grs. one-eighth, and hyoscine hydrobromide, one-three-hundredth of a grain, should be given. In

about fifteen minutes (with the average person) the patient will be so drowsy he will not be aware that he is being moved and will not be terrified by the operation room. In this condition the limb above the injury should be scrubbed with green soap and water, dried, then thoroughly bathed with alcohol, dried, and the Tr. iodine or a 5 per cent. alcoholic solution of picric acid, as the surgeon prefers, applied to the skin.

Unless the operation must be delayed on account of the condition of the patient, no attempt should be made to cleanse or disinfect the wounds, if

FIG. 5.—Crush of the upper third of the thigh with a tourniquet in place. Drawn from a photograph. As the condition required a hip-joint amputation it is obvious that the artist has placed the crush a little lower than it actually was.

the surgeon does not intend to have his incisions extend into the wound of injury.

If the operation must be postponed on account of the low condition of the patient and the limb is so shattered or comminuted that it is evident there is no possibility of saving it, a rubber tourniquet should be applied over, if practicable, if not, then immediately above the crush, and securely fastened and held in place; the wound may then be douched with volumes of hot hypochlorite solution, and sterile gauze wet with a strong hypochlorite solution stuffed into every crick and cranny of the wound. A mass dressing should be bandaged over the injured tissue. A splint or some proper support should be applied to the limb to hold it quiet and to prevent any movement of the part when the patient is carried to bed and nursed in bed.

If the morphia and scopolamine doses do not restore the strength of the pulse to a marked degree, and the systolic blood-pressure be found to be below 80 mm., major operative procedures must be delayed, and a transfusion of blood be made, if it is possible to secure a donor whose blood groups with the patient's blood. If this is not possible, hypodermoclysis of normal saline solution and glucose should be given, and if there is no contra-indication in the constitution of the patient, a dose of adrenalin chloride should be added to the hypodermoclysis fluid. Continuous proctolysis by the Murphy drip method should be continued for as many hours as necessary.

The writer has rarely employed intravenous infusions of saline fluid because they have not been followed by any good effect. Seldom have patients survived who had the intravenous infusions.

In the writer's experience, strychnia given hypodermically seems to have an excellent effect, and sometimes caffeine and camphor are added to the list of stimulants. The major indications are (a) add fluid to the circulation, (b) restore heat to the patient, and (c) inhibit pain with morphia and hyoscine. With this treatment, amputations may be delayed as long as forty-eight hours, even when the lower extremity has been crushed as far as the upper middle third of the thigh, and a good result be secured. (See Fig. 5.)

2. *Anæsthesia.*—Gwathmey's suggestion of synergic anæsthesia has been a great boon in all operative work, especially is it valuable in traumatic surgery. Preceded by morphia and scopolamine, when practicable, given one dose at least one hour, and a second dose if necessary, a half hour before the operation, only nitrous oxide and oxygen need be given for any major amputation. In regions of the lower forearm, and lower leg, by blocking the main nerve trunks above the line of incisions with 4 per cent. novocaine solution, the operation may in some cases be done with local anæsthesia alone after two full doses of morphia and scopolamine. It is usually best, however, to have some gas and oxygen given.

IN REGARD TO THE FORMATION OF STUMPS

The Configuration and Cutting of Flaps.—The surgeon should endeavor to secure for the patient a painless, well-rounded stump, the end of which shall have sufficient soft tissue covering, in addition to the skin, to make a proper protection for the end of the bone or bones. While it is true that muscular tissue in a flap placed over the end of the bone in a stump will soon lose its myosin and become a layer of connective tissue, this degenerated muscle nevertheless serves as a cushion and great protection for the ends of the bone. Besides, when the muscular elements of a stump are cut long enough to fit over the end of the bone, as a rule the skin flaps will be long enough to meet together without tension, they will be better nourished and will unite quicker and better.

In traumatic surgery the surgeon in cutting and forming his skin flaps must be governed by the condition of the injury, its location, and the individuality of the patient. He will, therefore, make many skin flaps which are not according to the best artistic standards. These flaps should be composed of skin not too much injured to be viable and always long enough and broad enough to come together without tension. The stump of an upper extremity may have only the skin to cover the ends of the bone; this should never be the case in the lower extremities, except amputations at the ankle- and knee-joints. One should whenever practicable cut the muscles of the stumps long enough to come together, at least in one layer, over the ends of the bone and in a direction and pattern corresponding to the skin flaps. Most careful hæmostasis should be practised in amputating a limb. The main trunk vessels and all the perceptible arteries should be ligated. Plain sterile catgut will suffice for this except in cases of shoulder and hip-joint amputations; here the main trunk vessels should be tied with chromicized catgut.

A most important thing is always to cut the main nerve trunks off so far above the end of the bone that they will not be caught in the cicatrix at the end of the stump. In the upper extremity, the nerves should be drawn out of their sheaths for at least one inch and cut squarely and evenly across with a pair of sharp scissors. In the lower extremity, two inches or even more of the main trunk nerves should be excised from the stump.

The cause of painful stumps when not produced by trophic retraction and ulceration will invariably be found to be from cicatricial pressure on the

FIG. 6.—Evulsion of both lower extremeties at the upper part of the thighs. Drawn from a photograph. The artist has not shown the clamps on the deep femoral vessels.

terminal nerve trunks. Usually a neuroma will be found. Scissors are better to use in severing the nerve trunks, because they squeeze the nerve fibrils together and close the neurilemma over them.

If a keen sharp saw be used to sever the bone aperiosteal treatment of the bone end is not necessary. Indeed, it is of very doubtful result in cases of bad crushes and much soiling of the wound, for there will be some infection. End of bones in stumps are very susceptible to infection and need all possible blood supply to ward off the evil consequences. Osteomyelitis is very apt to result in aperiosteal treatment of the end of the bones and necrosis of the end of the bone will occur. Exostoses about the ends of the bone do not occur without some infection. In order as far as practicable to prevent this, the writer has been in the habit of carefully protecting the periosteum on the anterior surface of the bone and to raise a cuff of periosteum half the circumference of the bone in width and long enough to fall over and cover in the end

of the sawed bone. This serves to cover the medullary cavity and lacunæ of the end of the bone, preserves the blood-vessels to the very end of the bone and assists in checking oozing of blood from the bone. This may be regarded as an antiquated practice and it is condemned by some modern operators and writers, but for forty years it has worked. Of the few reamputations which have been done at St. Luke's for painful stumps, not one of them was produced by irregular spicules or nodules, or exostosis of newly formed bone at the end of the sawed-off bone in the stump. Painful stumps result from illy-nourished flaps which are too scant in some direction, or from thick cicatrices located where they will be pressed or rubbed, and finally ulceration or, and especially, from nervous irritation produced by squeezed nerves, or neuromata resulting from the neglect to section the nerve trunks high up when amputating, to prevent the end being caught near the line of cicatrization, or where the prosthetic apparatus will press with most weight or leverage.

The muscular flaps and skin flaps should be united by interrupted sutures. For the muscular layer, chromicized catgut should be used, and for the skin flaps some hard-surfaced non-absorbable suture material.

After a major amputation there will be of a necessity considerable bloody serum exuded; this should be allowed to escape or be drained out of the wound, else primary healing will not occur. On this account interrupted sutures are recommended, and for amputations through large-sized limbs a drain of rolled guttapercha tissue, or a drainage tube should be brought from beneath the muscular layer at a dependent interval or opening between the flaps of the skin.

If for any reason when closing the wound the skin and fascial flaps are found too short to unite without marked tension, the bone must be sawed off higher up or else the wound should be left open and a resection of the bone be done later on.

As has been said before, except in rare instances of great stress and the vital importance of rapidity of operation, in industrial surgery, guillotine amputations should never be done. An experienced operator can amputate by the flap method almost as quickly as he can by the straight transverse circular method. In some rare cases of very bad infection, guillotine amputation may be permissible.

A stump after closure should be dried as thoroughly as practicable and a comparatively thick dressing of sterile gauze and cotton be applied. The stump should be firmly but not too tightly bandaged; the bandage should begin about twelve inches above the end of the stump, when this by the nature of the case is practicable, and the bandaging should proceed, contrary to the usual rule, downward towards the end of the extremity. A splint should be applied to the limb in order to keep it quiet and to stiffen it so that the patient may be moved to and in the bed without any separate motion of the member.

3. *Amputations of the Upper Extremities.*—As was said before, the surgeon should try to save every increment of bone length possible, without retaining devitalized flaps in amputation of the upper extremities. Since

aseptic operations are possible, the placing of the line of flap union is not of such importance as it was in the days when suppuration and thick cicatrices always occurred. This is especially true of amputations of the upper extremity. It is desirable that there shall always be sufficient length of flap to cover the ends of the bones without serious tension. One may use flap sliding methods by taking a flap from the side of the limb or even grafts from other parts of the body to accomplish this, however. It may be considered axiomatic that whenever the ends of the bones are left protruding from the end of a

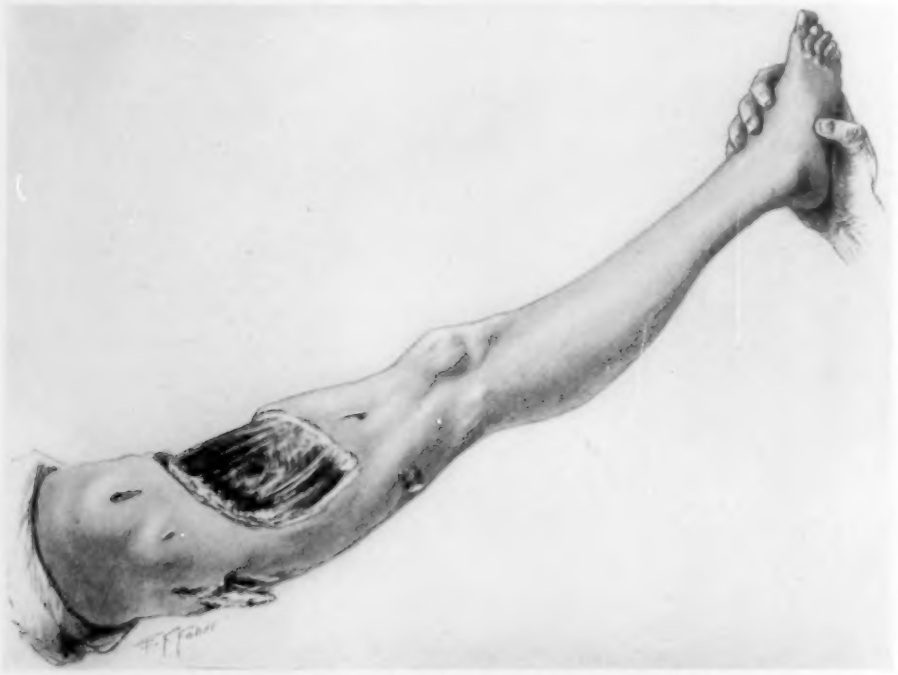

FIG. 7.—A compound comminuted fracture of the femur showing transverse laceration of the skin and longitudinal lacerations of the fascia and muscles. The extremity was saved.

stump uncovered and uncoverable, there either will be an osteomyelitis and necrosis of the ends of the bones, or else a secondary operation will be necessary, in order to secure a painless, as well as a useful stump.

In the arm one may accomplish something towards the final covering of the bones by traction downwards on the skin by adhesive straps. Only above the elbow is a guillotine amputation likely to heal with the ends of the bone finally covered and without the nerve extremities being squeezed by fibrous tissue, and a painful stump result.

(a) *Amputation of the Fingers.*—Palmar flaps long enough to cover the end of the phalanx should be used whenever possible without sacrificing length of phalanx. This is important both for the better protection of the extremity and for the preservation of the tactile sense in the ends of the amputated finger. The tendons should be left long enough to be sutured or caught within the flaps. They are very apt to retract if cut shorter than the bone

and adhere so high up flexion and extension of the distal end of the stump will be impaired. Even a short stump of any of the fingers will prove useful if the metacarpus is preserved.

When the condition admits of it, the metacarpus should be preserved intact. One is inclined, for the sake of appearance, when it is necessary to amputate the third or fourth finger at the metacarpophalangeal joint to exsect the lower extremity of the metacarpal bone or the whole bone. This destroys the integrity of the palm of the hand and leaves a less useful member. When the thumb or when only a part of the proximal phalanx of the thumb may be preserved, amputation through the metacarpal region after destruction of all the other fingers has occurred will leave a stump much more useful than any prosthetic appliance possible to obtain; when, however, all the fingers are irretrievably destroyed, the metacarpus will have been also so injured that it will be best to amputate at the wrist-joint.

FIG. 8.—Crush of the distal part of the foot, plantar aspect. Drawn from a photograph. The artist has magnified the appearance of the bloody soiling. The crush extends to the arrow points. Chopart's amputation.

(b) Wrist-joint amputations make useful stumps, if the styloid processes of the ulna and radius are sawed off. Antero-posterior flaps are best. The posterior flap should be about half again as long as the anterior one. The flaps should include all the tissues down to the bones. The skin element of the flaps should be longer than the fibrous tissues about the joint, however. As the tendons will not be of much use after this amputation, they may be

cut short enough for the other tissues to fold over their ends. The annular ligament should be preserved or as much of it as possible. The nerve trunks must be drawn down and excised at least an inch above the level of the sawed-off extremities of the bones. Pronation and supination are sometimes preserved after this amputation, but the loss of these two movements is of no consequence, as rotation of the radius will serve no useful purpose in prosthesis.

(c) Amputations of the forearm should always be done as low down as possible. Antero-posterior flaps using a long posterior flap as at the wrist-joint are best. The skin on the posterior surface of the forearm is thicker and better supplied with blood-vessels; it makes a better covering for the bones. In the middle and upper thirds one should in making his flaps dissect back the cuffs of skin from the fascia about half-way to the point at which he intends to sever the bone, then make a circular sweep through the fascia and muscles to the bones and dissect the muscles back without separating the intermuscular planes, hold them with retractors out of the way of the saw, and make a section of the bones together while they are in the position of full supination close up to the point where the muscles are folded back. No attempt need be made to separate the periosteum or to excise it from the lower part of the sawed-off bones. Aperiosteal amputations in this region are certainly not necessary and may lead to necrosis of the ends of the bones. The sharp edges left by the transverse section of the bones may be rounded off with a pair of bone nippers. A rasp is not a proper instrument to use in human surgery.

After carefully removing all particles of bone and shreds from the ends of the bones, apply a gauze sponge with firm pressure against the sawed ends of the bones. Find and ligate with plain sterile catgut all the principal arteries, then seek out as many of the muscular branches as may be found and ligate these. The venæ commites may be ligated with the arteries, provided the nerves are carefully separated from them. The superficial veins may be closed by torsion. Then remove the tourniquet, which should have been applied above the elbow-joint, ligate with plain catgut all bleeding vessels not controlled. Dry all the cut and dissected surfaces, draw the muscles over the ends of the bones after removing the sponge and hold them applied end to end to one another, in an antero-posterior apposition, by passing chromicized catgut sutures through the fascia and superficial muscular tissue and tying interrupted sutures so that there shall be but moderate tension in bringing them together. Bring the skin flaps together and secure them nicely approximated in good apposition with interrupted sutures of silkworm gut or some other hard non-absorbable material. There should never be any marked tension in bringing the skin flaps together. Time and again in the writer's experience he tried this and it always ended in disaster, *viz.*, loss of the flaps, separation of the flaps, and infection with great pain and distress for the patient. If flaps cannot be brought together without serious tension, they should be left open and not sutured at all or only with sutures so loose

and long, the flaps are simply retained in proper direction, but not brought together. The space between the flaps in these cases may be packed with gauze saturated with a 2 per cent. solution of Dichloramin-T in eucalyptus oil.

(d) Amputation at the elbow-joint leaves a very useful stump and may be very rapidly done. Inasmuch as the skin on the anterior surface is very loose and thin and retracts markedly when divided transversely, while that on the posterior surface is thicker and much more firmly attached to the deep fascia and retracts very little when cut, in amputations at the elbow-joint the best incision of the skin is a circular incision made on the line of the extremity of the olecranon process and the head of the radius.

FIG. 9.—Crush of the distal part of the foot. Dorsal aspect. Drawn from a photograph.

As soon as the skin is thoroughly severed and separated from the deep fascia, the incision assumes an oval form and the posterior segment will be much longer than the anterior segment. The brachialis anticus muscle should be cut long enough to make a good cuff in front of the end of the humerus, and as completely as practicable separate by rapid knife dissection the fibrous investment of the triceps from the olecranon. After thorough hæmostasis and exsection of the main nerve trunks about two inches above the articular end of the humerus, the tendon of the triceps may be united to the fibrous sheath of the brachialis anticus by chromicized catgut sutures. This forms an excellent covering for the end of the humerus. The skin should be sutured in an antero-posterior direction by interrupted sutures. In some cases it will be best to saw off the trochlear process of the articular end of the humerus, in order to square off the end of the bone.

The forearm is the region in which kineplastic methods are especially available. In amputations on account of recent crushes or evulsions these time-consuming operations, of doubtful success at best, do not seem applicable to industrial subjects. For individuals who may expend the time necessary for the proper healing and training of the improvised tendinous loops and extensions, kineplastic operations may be performed as, for instance, when amputations are done for some chronic diseased conditions or reconstructive work for former soldiers. Nevertheless, Vanghetti and Ceci who introduced the kineplastic methods, deserve the thanks and regards of surgeons for their ingenious and sometimes useful suggestions.

(e) *Amputations of the Arm.*—The lower third of the arm is the region of election, when a surgeon may choose. Almost equal antero-posterior flaps with a sufficiently long muscular section to cover in the end of the bone, is the method to be preferred, but this region admits of many variations and irregularities of flaps, with promise of good results, provided the flaps are adequate and no bad infection occurs.

The middle third also offers a region for good results both as regards quick recovery and advantage for prosthetic attachment. The circular method is the one to be preferred in amputating in this region. In very muscular subjects the skin may with advantage be slit laterally after the circular sweep of the long amputating knife has completely divided the skin, if it does not retract sufficiently to allow a circular section of the muscles at the proper level. The safe way, however, is to section the superficial layer of muscles about an inch above the level of the retracted skin, and when these have retracted cut through the deep layer about three-quarters of an inch higher up. Saw off the bone after the periosteal flap has been raised and pressed back with the anterior deep muscular layer, and the posterior layer of deep muscles separated from the bone to the same level as those in front.

After careful hæmostasis cut off the nerve trunks one inch above the ends of the bone, and two inches above the superficial muscular layer. The periosteal flap is brought down and fitted over the end of the bones, first the muscles, then the skin flaps are brought together by interrupted sutures in an antero-posterior position. Only the superficial layer of muscles require suturing together over the bone.

After dressing and bandaging the stump, fasten it by some circular turns of a wide bandage to the side of the chest. In this way the stump is kept at rest and is well supported. Amputations of the upper third of the arm may be done after the same general manner, only it is better not to do the circular incision here, use antero-posterior flaps fashioned, with a short knife, with the skin well divided on either side of the arm. This high amputation of the arm is to be preferred to a shoulder-joint amputation, because it is possible to use a tourniquet and control the blood-vessels and because the death-rate is a little less than the amputation at the shoulder-joint, but it offers no chance for a successful prosthesis; the stump will be too short.

Amputations at the shoulder-joint are not rare operations in industrial

surgery. The upper extremity is apt to suffer in machine shops, and factories generally from long belts and whirling wheels which catch it and wrench or tear it off high up above the elbow. On the railroads also crushes of nearly the whole upper extremity occur, but less frequently. As a rule, when a man has suffered such destruction of his upper extremity that a shoulder-joint amputation will be necessary, he will have received other injuries, frequently multiple injuries, of a serious kind. The hazard of a shoulder-joint amputation is thus greatly increased in many instances by these other serious wounds. It is of vital importance, therefore, to prevent hemorrhage.

An Esmarch tourniquet may be used in most instances by applying it high up in the axilla and around over the neck of the scapula and outer third of

FIG. 10.—Crush of the upper forearm showing incisions made for relief of tension and for drainage. The extremity was saved. Drawn from a photograph.

the clavicle. An assistant should prevent it slipping down by drawing firmly upwards and towards the opposite side by a section of a strong muslin roller bandage laid transversely under the axis of the rubber tourniquet. The brachial or axillary vessels should be found and ligated before the disarticulation at the shoulder-joint is done, else they are apt to slip under the tourniquet when it slips down and compresses the soft tissues when bereft of the support of the bone. The main vessels having been tied, the sectioned soft tissues may be held upwards by thick gauze compresses. The tourniquet may now be removed and the disarticulation accomplished while the muscular vessels are controlled by pressure of the compresses. The circumflex vessels give most trouble to find and to control as a rule.

A long anterior flap and a posterior flap half its length furnish, when the wound is properly closed, the best stump. As much of the deltoid muscle as practicable should be included in the anterior flap. The pectoralis major and latissimus dorsi muscles should be cut close to the bone. If they tend to retract markedly their tendons may be sutured to the short muscles in the anterior and posterior flaps, respectively, or they may be sutured together across the glenoid cavity. The large nerve trunks should be drawn out and

severed at least two inches above the section of the muscles. Drainage by a tube at the most dependent angle, namely the outer angle, should be used as there will be considerable bloody serum exuded. This tube should extend to the lower rim of the glenoid and be fastened in place by a suture through the skin flaps.

4. *Amputation of the Lower Extremities.* (a) *Amputation of the Foot.*—Amputation of toes requires less nicety of technic as regards flaps, than amputation of fingers. One may make his flaps in any direction, in order to obtain good skin and flaps long enough and broad enough to cover in the end of the stump without tension.

Plantar flaps are best, however. The great toe is the important member below the metatarsus. Sedulous care should be used to preserve it, since without it modern human beings will lose most of their propulsive power in walking. Amputations through the metatarsal region and at the tarso-metatarsal joint require long and viable plantar flaps in order to be useful and painless. If these may be obtained, the result will be a most useful member, unless infection occurs. Medio- and trans-tarsal amputations have been successful and left most useful stumps. Hay's, or Chopart's methods have been most frequently employed. The special points to observe are first, good plantar flaps just long enough to fit snugly over the ends of the bones; second, the extensor tendons on the dorsum of the foot must be preserved just long enough to meet the plantar flaps without tension and be sutured securely to this flap. The shortened foot must be bandaged and firmly secured in a position of right angle or even a lesser angle at the ankle-joint. If this cannot be done without section of the tendo-achillis, this section should be made inside of a week, else it will do no good. If the amputation has been done properly and the foot secured in a position of rather marked extension, it will not be necessary to cut the tendo-achillis.

Syme's amputation has also given good satisfaction. One must always be careful to see to it that the blood supply for the tissues of the heel are preserved, else a part, at least, of the heel flap will slough.

Osteoplastic amputations of the foot rarely may be used in traumatic surgery. They belong to chronic pathological conditions and to reconstructive surgery.

(b) Amputations of the leg, lower third, as was said before, should be selected rather than the middle third. A long anterior flap and a posterior one-half its length produce the best stumps. These flaps must be cut wide and long enough to cover in the bone without any tension.

Square-cornered flaps are best in this region. The tendons and muscles should be cut an inch and a half shorter than the skin flaps and they should be incised with a sharp knife, so that the section shall be a clean, even, transverse cut down to the periosteum. The periosteum should be carefully preserved from nicks of the knife or injury from other instruments, and that of the tibia should be incised so as to make a cuff long enough to fit over the whole end of the tibia when it shall have been severed.

The space between the tibia and fibula should be incised with a sharp, narrow knife (an old-fashioned catlin will serve the purpose, but it is not absolutely necessary) and soft tissues carefully dissected away and held back by a retractor at least three-quarters of an inch higher up than the place at which the tibia will be sawed off. All the soft tissues should now be carefully protected so they may not be injured by the saw. The tibia and fibula are sawed through and then the sharp upper shin angle may be sawed, or nipped, away with a pair of sharp bone nippers, so as to make the tibial section oblique immediately under the periosteum. The periosteum of the fibula need not be stripped or saved, but severed cleanly at the point at which the saw shall traverse the bone. When for any reason a cuff of periosteum will not be made and used, great care should be employed in amputating a leg to see to it that no strips or shreds of periosteum are made and left in connection with or in juxtaposition to the ends of the bones. These shreds and loose ends may produce new bone which will serve as exostoses later on. A cuff of periosteum when properly treated and located produces no exostosis as was said in an early section of this paper. One should always find and recognize the peroneal nerve and cut it off an inch further up than the end of the bone; the tibial nerves should also be treated in the same way; they, however, are readily seen, but the peroneal may be hidden and escape attention. This method of amputating the leg brings the union of the flaps and later the cicatrix well towards the rear and out of danger from pressure of the end of tibia when a false leg will be used. Lateral flaps also make good stumps in the lower leg.

FIG. 11.—End of a stump of the leg, middle third. Antero-posterior flaps used. The man works in a steel mill, with the assistance of a false leg and has used the stump for about seven years, without difficulty or pain.

Amputations through the middle third of the leg may be done with the same kind of flaps and by the same technic as the one just described for the lower third. On account of the desirability and possibility of retaining more muscle in the flaps, and on account of the fact that by odds the thickest layers of muscles will be in the posterior flap, and that these thick muscles of the calf are so heavy they tend to drag the anterior flap down upon the end of the tibia when the suturing of the flaps is complete, and a local slough from this pressure may result, the writer has found the lateral flap method especially adapted to the mid-leg region. If good muscular flaps may be obtained under the skin and union without suppuration be obtained, the antero-

posterior cicatrix will be only a thin line and will bear as much pressure as is necessary. The lateral flap method, too, provides for much better drainage and permits the use of lateral splints to support and immobilize the leg; the lateral splints in turn support and help keep the flaps in place.

Amputations through the upper third of the leg should not be done for the reasons already stated.

Amputations at the knee-joint should be done by a long anterior and short posterior flap method. The anterior incision of the skin should begin just below the head of the fibula on the outer side of the leg, and be carried across just below the tuberosity of the tibia and extend to the inner side of the leg to a point corresponding to the level of the initial incision. For a right-handed operator this will require him to stand between the legs of the patient in order to make the incision comfortably and quickly on the left extremity of the patient.

The posterior flap should be less than one-half the length of the anterior one. One must bear in mind, however, in shaping this posterior flap, that the skin will retract very markedly and he must allow for this in judging the length of the flap. Many times a surgeon finds his flaps will not meet after finishing the section at the knee-joint, because he had neglected to allow for the immediate and very remarkable contraction of the posterior flap. In dissecting the skin away for the anterior flap, care should be used not to cut or injure the patella tendon. This tendon should be dissected away from its attachment to the tubercle of the tibia in such a way that as much length of tendon as possible shall be preserved. Also when cutting through the popliteal fascia and popliteus muscle a flap only a little shorter than the posterior skin flap should be preserved. After disarticulating the leg bones, most careful hæmostasis should be seen to, the popliteal nerve drawn out and cut short, then the tendon of the patella may be sutured to the popliteal muscle and fascia. This will retain the patella about in its normal position and the tendon and posterior fascia will serve to fill in the intercondyloid groove of the end of the femur. (See Fig. 2.) In case it is not possible to get as long flaps as indicated, it will be best to cut the quadriceps femoris tendon just above the patella, thus removing the patella entirely. In this case the articular end of the femur must be sawed off and removed, then the quadriceps tendon may be united over the end of the femur to the popliteal fascia behind.

Knee-joint amputations should produce good weight bearing and painless stumps and they usually do when properly made.

Amputation through the lower third of the thigh should also be done with a long anterior and a short posterior flap; in this case, however, the posterior flap need be only one-half shorter than the anterior. The fascia and muscles should be cut long enough to be sutured over the end of the bone without tension, but fairly snugly.

This is the region of election for thigh amputations when one may choose. The stumps may be made weight bearing by proper care, practice and exercise, while the patient is convalescing.

Upper third of the thigh amputations may be done with the same technic as those of the lower third, but one should try to make the section of the bone as low as possible. Equal antero-posterior or long external lateral flaps, or even irregular flaps, may be employed, in order not to amputate too high up. Every inch counts in the probability of recovery of the patient. (*See the Tables.*)

A guillotine amputation may be pardoned in this region in order to conserve the patient's chances for recovering, as was said before.

Hip-joint Amputations.—Extended experience has confirmed the opinion expressed in former papers, that no attempt at controlling the circulation by any manner of constrictors or constrictions, however applied, or by whatever method secured in place, is necessary to obtain the best results in hip-joint amputations. What the writer has called "the gradual dissection method" has been found best in every respect. One may tie the common femoral vessels just below Poupart's ligament, before he begins the dissection of the flaps. However, he must be sure he has ligated above the beginning of the deep femoral.

FIG. 12.—Stump of a forearm upper third. Antero-posterior flaps used. A useful stump for eight years.

In industrial surgery it is not always possible for the surgeon to select the manner of flaps nor to apply any regular prescribed method of shape or size of flaps, when he amputates at the hip-joint. He must use such skin and muscle elements as are viable and available for covering in the pelvic bones and for uniting soft tissues, in order to make some sort of stump; he should, however, select the direction of the flaps, when possible, in such a way as to bring the line or lines of union as far away from the anus as possible, in order to avoid the danger of fecal soiling and infection from the colon bacillus.

In cases which permits of a formal selection method and technic and which will admit of a deliberate, not necessarily a slow, operation, it will be best to ligate the femoral vessels near the base of Scarpa's triangle a little below Poupart's ligament. The anterior central longitudinal incision necessary in order to ligate the vessels will not serve as a boundary and should not delimit the anterior flap. The so-called racket flap amputation is not the best one at the hip-joint. About equal width antero-posterior flap method is

best; the posterior flap made longer than the anterior one so that the skin and gluteal muscles may be drawn upwards and forwards when the flaps are sutured together, one thus may use the proper muscles, the gluteals, to round off the stump and bring the line of flap union far enough away from the anus to be perfectly safe from infection. When the condition of the seat of operation will permit it, instead of using the Furneaux-Jordan method, one may employ the suggestion of Major Kirk, namely, saw off the femur through the greater trochanter and not attempt to disarticulate. This saves much time and preserves more support for the flaps.

FIG. 13.—Showing the end of a stump of the forearm. The furrow on the extremity was made by the band which attaches the prosthetic apparatus to the extremity. The man is employed in a steel mill and works every day for about six years.

Beginning then just at the upper border of the adductor longus muscle the incision may be carried in a broad oval across the upper third of the thigh, convex downward. The soft tissues should be severed gradually just as one does in removing a large tumor, and all blood-vessels should be grasped by hæmostatic forceps. If any small vessels are cut during the dissection, they should at once be grasped by forceps and clamped securely. Every possible care must be used to prevent loss of blood. Muscles should be cut shorter than the skin flaps and each successive layer be divided as the dissection reaches it, and be made shorter than the superficial layers above it. The rectus femoris, the sartorius and adductor longus muscles should be divided about on the level of the lower end of the incision used to ligate the femoral vessels. As the common femoral should have been ligated above the level of the beginning of the deep femoral, there will be very little hemorrhage to control in the anterior flaps. One must be very careful in dissecting the posterior flap, however, to anticipate the cutting of the vessels. The surgeon should be well grounded in the anatomy of the upper thigh, especially as regards the location of the chief blood-vessels. A drainage tube should be inserted to the lower rim of the acetabulum and brought out at the outer and lower angle of the united flaps and be held firmly in place by a suture passed through the anterior and superior skin flap, then through tube, and out through the skin of the posterior flap.

RESULT OF AMPUTATIONS

(a) *With Regard to Mortality.*—The table which follows will indicate that amputations have a low death-rate when done with careful aseptic technic and with careful consideration of the patient's general condition, especially with regard to the blood-pressure and other indications of excessive loss of blood and strength. Fifty-eight of the single amputations were done for diseased conditions, five of these were hip-joint amputations. The only death following these operations was after a hip-joint amputation done in the case of a man who was nearly exhausted from the effects of an osteosarcoma high up in the thigh. These major amputations were performed upon patients of all ages from ten to eighty-four years; one old man seventy years old died; the other deaths occurred in the cases of individuals between fifteen and forty-five years of age. The mortality rate was not influenced greatly by age, it would seem, but it is a fact that most of the cases were adults, and working adults, therefore men and women who were supposedly in sufficient vigor to do hard work. While these people who were operated upon were not selected individuals, as soldiers are for their good physical condition and strength and without evidence of serious ailment, they were the average adult worker.

These tables may be taken as proper and fair evidence of the expectation of life after major amputations in the average population of our industrial centres.

Of the 727 cases of single major amputations, 31 died, a general mortality percentage of 4.26.

There were 46 double synchronous amputations with 3 deaths, a mortality rate of 6.5 per cent.

There were 3 triple synchronous amputations and no deaths.

Besides there were 18 cases of major amputation and some other operation of major importance done at the same time; these are called "mixed operations." There were 3 deaths. Rate, 16.66 per cent.

There were 6 cases of two amputations and some other major operations done at the same time. No deaths.

There was one quadruple mixed operation; the patient recovered.

All of the deaths except seven occurred within forty-eight hours from shock and exhaustion; seven cases were infected and died of septicæmia.

(b) *With regard to usefulness of the stump* and subsequent lack of ability of the patient.

On account of the fact that patients are inclined to consult another surgeon when they find the result of their operator's work not satisfactory, it is quite possible that some patients have not reported painful, diseased or useless stumps to the clinic, nor to the chief surgeon.

As far as reported, or of which any record could be obtained, 19 patients had painful or diseased stumps (ulcerated stumps) and required re-amputation.

One, the case of a young boy, required re-amputation of the upper arm on account of the shaft of the humerus elongating after amputation.

Twelve cases of leg amputations had ulcerated stumps or developed conical stumps, and 6 cases of thigh amputations required re-amputation for painful or ulcerated stumps.

Conical stumps will always develop in young people whose bones are not fully grown, especially if the amputation be done through the upper diaphysis of the humerus or femur. The leg bones may also grow sufficiently to produce conical stumps, but are not as apt to do so. Parents should, therefore, be warned that another operation will probably be required in a few years when children's limbs have been amputated through any region except at the articulations.

It was found almost invariably that painful stumps were produced by nervous irritation of the ends of the nerve trunks, and in the majority of these painful stumps a neuroma was found, and the nerves terminated too near the cicatrix of the united flaps. Ulceration resulted as a rule on account of inadequate flaps and wide cicatrization, rarely from the pressure and rubbing of an improperly fitted and ill-adapted prosthetic apparatus.

There is no record of exostosis at the end of the bone of the stump causing any pain or difficulty.

The permanent disability of an individual after amputation will depend upon the work, trade or business of the person. And also upon whether the upper or lower extremity has been amputated, and at which region of the extremity. Disability in terms of earning capacity for a working man is much greater when any part of an upper extremity above the hand has been lost, than when a lower extremity was involved.

The International Association of Industrial Accident Boards and Commissions rates the permanent disability of a workman who has lost an upper extremity above the elbow at 75 per cent. and from an amputation below the elbow at 60 per cent. This is correct, but to reckon 75 per cent. disability for a man who has had his leg amputated above the knee is not at all correct. Also 50 per cent. disability for an amputation below the knee is far more correct, if applied to the future ability of the worker to earn a living.

The writer has known many men who earned just as much, or more, money after an amputation of the lower extremity anywhere below the mid-thigh region than they did before, and these men had no difficulty in walking or getting actively about by the use of a well-fitting false leg.

Conclusions.—1st. Amputations for industrial injuries owe their fatalities chiefly to loss of blood, or to other injuries received at the same time as the one requiring the amputation.

The average death-rate for single major amputation should, however, be low. (*See the tables which show mortality rate for the several regions and the general or aggregate mortality rate for all amputations.*)

2nd. The surgeon should not amputate until the patient has reacted from shock. This will be indicated by the blood-pressure. The operation should be done, if there is no strong contra-indication (and there will be much less danger of sepsis, if the amputation shall be done) within three hours after the

injury was received. Sedulous care must be taken to control hemorrhage in any case of delayed operation.

3rd. Synergic anæsthesia seems to be best in operating for serious industrial injuries. Chloroform should never be used, and only very little, if any, ether.

4th. A study of a group of 100 single major amputations shows the average time in the hospital after amputation is twenty-two days. This, however, does not correctly express the time of disability. It means simply that the wound is healed and that the patient is able to get about.

In common with all other industrial injuries there should be for "amputated" men a period of rehabilitation in the hospitals. The stump should be exercised, massaged and manipulated so that it shall be prepared for wearing and using properly a prosthetic apparatus. Also this apparatus should be made under the direction of the surgeon in charge, and the patient should never be allowed to leave the care of the surgeon until he has received and proved that he can wear and use the prosthetic appliance without pain and with efficiency. Patients must learn to use these artificial aids and they will

TABLE I.

Single Major Amputations

	No. of operations	Deaths	Mortality percentage
Amputations of arm	78	1	1.28
Amputations of elbow-joint	3	0	0
Amputations of forearm	69	0	0
Amputations at shoulder-joint	48	2	4.16
Amputations of foot, Chopart's	15	0	0
Amputations of foot, Hay's	32	0	0
Amputation of foot, Lisfranc	1	0	0
Amputations of foot, Pirogoff's	3	0	0
Amputations of foot, Symes	22	0	0
Amputations of foot, Mikulicz	2	0	0
Amputations of leg, lower third	123	2	1.62
Amputations of leg, middle third	69	0	0
Amputations of leg, upper third	29	1	3.44
Amputations of thigh, lower third	112	8	7.14
Amputations of thigh, middle third	49	8	16.32
Amputations of thigh, upper third	19	4	21.0
Amputations at knee-joint	41	1	2.43
Amputations at hip-joint	12	4	33.33
Total	727	31	4.26

use them best under skillful direction and oversight. Artificial limbs should be applied just as soon as the stump is solid enough to bear them or bear upon them. For a leg or thigh amputation, the artificial limb should be worn within two months after the operation. It is true that the stump does shrink

after a little while, but so do the unused muscles of the extremity. If the false limb is delayed for four to six months there will have occurred so much atrophy that the stump will be too weak properly to operate the rather heavy false limb.

5th. Final compensation adjustment should be delayed for at least two years after an amputation, for the majority of work people will be able to earn quite as much as they did before the injury, by this time, if they have lost one leg or a part of one lower extremity below the mid-thigh region. No prosthetic appliance can fully or nearly fill the need of a lost upper extremity.

Amputations of forearms and upper arms produce as a rule irremediable disability, but the person who has lost an upper extremity may learn to do many things by the use of very homely and sometimes home-made prosthetic apparatus. No apparatus which imitates the appearance of a lost hand or forearm is ever of any great use in the everyday duties of a workman. Home-made hooks and clamps, which may be inserted or fastened to the end of a simple socket fitting over the stump of an arm, assist greatly and are useful helps in doing a workman's daily employment.

THORACIC SURGERY AS A SPECIALTY

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Without concerning ourselves with meticulous definitions, a specialty in surgery may be regarded as a branch which requires particular training for the treatment of the disorders of certain organs or even regions of the body. Thus, opthalmology dealing with an organ whose tissues with their functions and reactions differs widely from those of the rest of the body has developed as a result of study and experiment into the highly individualized form which we recognize to-day.

Other organs, such as the ear and the larynx, have long been regarded as legitimate fields for special study and practice. And no one would deny the right of odontology to its own highly differentiated position.

Not so, however, with the fragments more recently torn from the parent body of surgery. This has been accomplished only in spite of violent protest from the old practitioners. But progress can not be checked and the specialties have come to stay. Indeed, they are becoming subdivided. For example, the "eye-ear-nose-and-throat" branch of not so long ago has by degrees separated itself into its component parts and has become three specialties instead of one.

Whether or not the objections are valid which arise with the birth of each new surgical "ology" most of the newcomers appear to have justified their existence so that the workers in special fields are deferred to by their colleagues of the most inclusive divisions. There is, however, one point which must not be lost, namely the absolute necessity for a foundation in general surgery. Unfortunately, this requirement has not always been observed and many have entered the practice of special branches with little or even no intimate knowledge of the broad principles of surgical diagnosis, and procedure—to the great detriment of their professional activities. No one should undertake the practice of a specialty who is not able to cope with its more frequent complications, particularly those which may arise during operative treatment and also those depending upon remote pathological developments.

For forty years the Annals, under the able and scholarly direction of Dr. Lewis S. Pilcher, has marked the growth of surgery from the time when an exclusive practice in this branch was a novelty. And as each specialty appeared its achievements have been recorded, so that here under a single cover we may observe the evolution and functions of this ever-increasing brood.

Before stating the reasons for the opinion that Thoracic Surgery should be regarded as an individual branch of practice, let us enumerate the essential factors of a specialty.

1. *Anatomy.*—This must be mastered in a detailed manner not usually undertaken in the ordinary course of medical study. To the descriptive and topographical divisions must be added a knowledge of embryology with its faults which result in anomalies, while the minute structural anatomy and the changes resulting from disease may not be neglected.

2. *Physiology.*—The functions of the region, and its organs which are to be the subject of special surgery, must be understood to the limit of our present knowledge. This is necessary because even more important than the preservation or restitution of anatomical form is the conservation or restoration of function.

3. *Special technic* must be acquired and often it is necessary to learn how to employ complicated instruments or apparatus devised for use solely in operations upon the parts which form the special field of practice.

4. *Frequency.*—In deciding the legitimacy of a specialty, the frequency of the conditions which demand its practice must be considered; diseases occurring but rarely do not present a sufficient opportunity for the development of wide experience. Yet, even when the field at first appears limited, it is often amazing to note how rapidly it increases as more and more reasons for its application arise. The scope of bronchoscopy, for example, has rapidly widened from the mere extraction of foreign bodies to the diagnosis and therapy of many pulmonary lesions such as abscess of the lung, tumor of the lung, bronchial narrowing, bronchial ulceration, to which Chevalier Jackson has recently added the mapping of the bronchial tree for X-ray demonstration and localization.

Now, let us inquire into the claims of thoracic surgery to be regarded in the dignified light of an individual branch of practice. Taking up the foregoing headings in order, we find that in Anatomy the chest wall with its elastic bony and cartilaginous framework, its dorsal vertebral column, its muscular, vascular, nervous and other structures, have always been subjects for lecture and study in the medical school. Operations upon the chest wall which do not invade the cavities of the thorax form a large part of general surgery, the commonest major procedures being those concerned with the female breast; while the diseases and deformities of the vertebral column and the ribs are extensively treated by orthopædic therapy, operative or not. The thoracic cavities, however, and their contents have not usually been studied in such a particular manner as to breed the same feeling of familiarity which has become a matter of course when dealing with the body in general. It is the pathologists through post-mortem examinations who have become proficient in orientation of the thoracic viscera and with their anatomical appearances, while it is the medical men, or so-called internists, who from physical examinations and röntgenology have learned the position of the organs within the chest and how to recognize the changes which can be elicited by auscultation and percussion. The surgeon who intends to occupy himself with operations upon the organs and spaces of this region should perfect his knowledge

of clinical examination and should learn the appearances of the interior of the chest both in the living and in the dead.

The physiology of the thorax and its organs is most complex. The reactions to such an apparently simple influence as open trauma of the pleura which, it would seem, should be easily explained by a study of its mere mechanics, are still under investigation, and the conclusions reached by various observers have led to considerable argument. The surgical possibilities in the case of the heart and great vessels, and even of the thoracic œsophagus, have by no means been formulated, though very promising work is still going forward.

In the heart and great vessels the experimental work of Elsberg, Carrel, Tuffier, Cushing and others have shown what may be expected in future operations in human subjects and, as a culmination during the past year, we have the brilliant case of Cutler and Levine in which an almost moribund child was successfully relieved from the symptoms of advanced mitral stenosis by transventricular valvulotomy. They reported another case of a similar nature in which success might have been achieved but for an unfortunate post-operative fatal pneumonia. With the aid of the ingenious operating cardioscope of Allen and Graham, we may hope for other successful endocardial procedures. The great vessels have been approached and operations undreamed of in the past are now regarded as well within the bounds of possibility. The recent successful extraction of an embolus from the pulmonary artery by Kirschner of Koenigsberg,* according to the method of Trendelenburg, is but another instance of what we may expect in the future as a result of intensive work in thoracic surgery. To these may be added many other illustrations. Among them are operative recoveries following resection of the cancerous thoracic œsophagus in cases of Lilienthal, of Hedblom, and then of Eggers reported years after Torek's brilliant case proved to the world that such a procedure was more than a dream. We may predict that with timely recourse to surgery we shall soon begin to regard these results as quite a matter of course. The entire subject is still new. Whether eventually the transpleural or the mediastinal approach will prove the safer further experience alone can tell—perhaps even a combination of the two. At any rate, if radical cure is to be hoped for, it is to surgery that we must look. Radiation should be reserved for the inoperable cases, but this is not the place for a full discussion of the subject.

The pleura in the absence of inflammatory changes is so intimately connected with the lungs and with respiratory function that the operative treatment of its pathological conditions, except in the emergency of traumatic injury, deserves to be placed in the hands of those who have been instructed in the management of its peculiar reactions. From the anæsthesia, local or general, with its problems in physiology, to the closure of the wound and its peculiar forms of drainage, an operation upon the uninflamed pleura presents

* Personal communication from Dr. Willy Meyer.

conditions which differ so materially from those of other body cavities that it may be compared to a procedure of election upon the central nervous system. It is far more remote from general surgery than is gynæcology.

Suppurative infection of the pleura—empyema—was until recently regarded as a simple condition in which drainage through a single incision, preferably with subperiosteal costectomy, would ordinarily effect a cure with no important pathological sequelæ. When an empyema failed to heal after operation various measures were taken to obliterate the residual cavity, often by some variety of deforming thoracoplasty. The primary drainage was considered as one of those anomalous procedures formerly known as "medical operations" and was in the hands of the general practitioner, the case becoming "surgical" only when extensive secondary operations were needed. How the empyema originated, whether by a general infection or by the rupture of an abscess, pulmonary or otherwise, was rarely investigated and post-mortem examination revealed terminal conditions which were seldom traced to their beginnings. Only since the development of thoracic surgery with its early and free exploration are we beginning to acquire systematic knowledge of the subject. The result has been a great improvement in both chronic morbidity and in the death rate. Yet, even at the present time the modern surgery of empyema is practiced intelligently by a small minority. This is shown by the condition in which many chronic cases are presented to the surgeon for secondary operation. Undrained and unsuspected residual cavities, abscesses of the lung, suppurative bronchiectases, retained foreign bodies—this is but a small list of the causes of chronic suppuration with fistulæ through the thoracic wall or into a bronchus; and in most instances correct diagnosis and proper treatment in the beginning would have avoided long illness and operations of alarming magnitude. It should not be understood, however, that every case of empyema must at once pass into the hands of the specialist. Ordinarily, the time-honored drainage methods may be acceptably undertaken by any qualified surgeon. Empyema rarely calls for immediate radical operation and time may nearly always be gained for more complete diagnosis by evacuation through needle or cannula with subsequent röntgenological examination. The details need not here be considered. It is sufficient to say that when ordinary drainage does not result in uninterrupted convalescence, the thoracic surgeon should be given the opportunity to act before the case develops into what we ordinarily mean by the word chronic.

A consideration of infections and injuries of the lungs provides us with the same arguments which we have employed in speaking of the pleura, but here treatment by operative measures is fraught with much greater danger to life while restitution to the normal is more difficult. Among the commoner diseases are the putrid bronchiectases. Therapy, even by the most modern methods, whether by bronchostomy, resection or cauterization, is accompanied by grave risks. Plastic compression and fixation of the chest will sometimes

give great relief but seldom cure. No more grateful individual exists than the one who has at last been rid of this foul, ostracising and dangerous disease.

By operations looking toward compression of the lungs and partial obliteration of one thoracic cavity, cases of unilateral tuberculosis of the lungs often may be quickly and favorably modified, thus greatly aiding the sanatorium cure by rest and hygiene. Bedridden patients have thus been converted into useful members of society in a surprisingly short time. The operation itself as perfected by Sauerbruch when divided into stages and performed in judiciously selected cases, is a great boon to a large class of sufferers. It is rapidly growing in favor and has now been performed many hundreds of times. Although the chest wall only should be concerned with the actual operative work, yet this form of thoracoplasty demands a knowledge of phthisiology as well as of the direct effect of the changed conditions which are brought about both in the more diseased lung and in its fellow as well as in the mediastinum and its organs. Its possibilities were first appreciated by thoracic surgeons and its execution, though apparently simple, is so intimately related to the progress of the tuberculosis itself that to obtain the best results the coöperation of a skilled phthisiologist is necessary, as well as post-operative sanatorium treatment. With the ever-increasing interest in this important phase of surgery, there is much danger that the operation may be undertaken by the comparatively untrained, to the eventual injury of operator and patient.

Among the non-inflammatory diseases of the lung probably the most important are the primary malignant neoplasms, a class of cases most outrageously neglected. The mere ablation of a part of the lung through uninfected tissue has been shown experimentally, and also in certain cases of war wounds to be comparatively free from great risk. The resection of *infected* lung, on the contrary, is one of the most perilous in surgery. Yet it is indeed rare that the thoracic surgeon has the privilege to operate in cancer of the lung before secondary infection has added forbidding complications. With the bronchoscope and the X-rays an early diagnosis is possible while the clinical history is characteristic. In nearly all other parts of the body the early suspicion of malignancy is the signal for operation while in the lung the cases are—let us say—played with until it is too late. Volumes have been written on every conceivable medical aspect of the subject. Almost nothing has been said of the only treatment which holds out hope. Another fifty years will probably have demonstrated how timid we are to-day.

The diaphragm, though it belongs both to the abdomen and the thorax, can be best approached from above. Also, the physiology of its action is more important to the chest than to the abdomen. Operations upon this muscle and upon the nerves which control it may well be classed among those of a veritable specialty.

As to the technic of thoracic surgery little need here be said. The methods of incision, hæmostasis and exposure are not difficult to acquire, but the correct application of surgical principles can only be learned through long study

and practice while in no branch is attention to peculiarities of detail more indispensable to success.

In surgery of the chest are encountered unique accidents which for swift and terrible results are not matched in any other branch. Among them are the shocking mediastinal flapping when one virgin pleural sac is opened, the suffocating tense vascular pneumothorax and, most dramatic of all, cerebral air embolism in the course of a minor procedure such as the irrigation of the rigid cavity of a chronic empyema—an ambulant, convalescent patient, joking with the surgeon one minute and in the next writhing in convulsions which are often quickly followed by death—or the drainage of a lung abscess with everything going well when the early signs of multiple brain abscess give the signal of failure and an inevitable fatality.

Our last requisite of a specialty, namely, that there should be sufficient opportunity for its practice, is certainly not lacking in the surgical disease of the chest, even excluding the commonest one, empyema. Yet, with this exception, the number of thoracic operations listed at the various hospitals is surprisingly small. The New York Academy of Medicine publishes daily a list of operations which are scheduled in nearly all the hospitals of the Greater City. Careful perusal of these programs informs us that operations upon the intrathoracic organs are very rare, the proportion to those of all other surgery being less than one in five thousand. Abscess of the lung, particularly the chronic type, is treated medically in most hospitals and the patients, discharged improved or unimproved, enter other institutions for further medical care. The status of cancer of the lung has already been considered. It is a disease by no means rare, but often unrecognized in spite of its characteristic clinical history. Cancer of the œsophagus is sent to the surgeon, not in its incipient and operable stage but—alas! for gastrostomy when starvation is imminent. Tumor of the mediastinum is treated by various forms of radiation with almost universal failure when growths of large size are often removable by operation. It is not necessary to catalogue further.

The experiences of the World War have made surgeons less timid in attacking thoracic conditions, but the treatment of penetrating trauma of the chest is not comparable to that of diseases in civil life, for the former come as emergencies at once to the surgeon and procrastination is therefore not common.

I have here tried to demonstrate that thoracic surgery is in the true sense a definite and individual branch; that its practice requires special study, training and experience. The death rate of its operations is high, but with further development of technic and with growing wisdom in the selection of the procedure to suit the cases, it is bound to diminish. Above all, we must look to the slowly growing realization of the possibilities of thoracic surgery for an increasing opportunity for its application. We must not forget the days when internal medicine claimed the right to treat surgical abdominal conditions such as appendicitis and only the desperate far-advanced cases were referred for

operation. The growth of chest surgery must necessarily be slow by comparison because at present it looks as if the proportion of patients suffering from operable pathological conditions of the thorax were much smaller than those with abdominal lesions, so that adequate experience will be long in coming. Still, reading the future by the past, more and more will intrathoracic surgical lesions be recognized, and earlier referred for operation.

Nowhere in the art and science of healing is the unselfish coöperation of the physician and surgeon so vital as in the treatment of the deranged thoracic organs. With medicine and surgery working for the same object without rivalry and without envy, we may look forward to the future of this great new specialty with confidence and hope.

GAS GANGRENE

WITH SPECIAL REFERENCE TO ITS TREATMENT

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The unfortunate outcome of the majority of cases of gas gangrene which have been reported in the literature, leads one to infer that notwithstanding the lessons so dearly learned during the World War, the pathology, physics and extent of operative interference demanded in these cases is as yet not entirely appreciated.

The subject is by no means a new one, for as long ago as 1853, Maisonneuve [1] gave an excellent description of its course, and Salleron in

Fig. 1.—Gas gangrene of forearm after primary débridement. Note typical œdema of internal aspect of upper two-thirds of forearm. Full arm wrap dressing of quino-formol applied only.

1854 reported some sixty-five cases observed during the Crimean War, while Bottini,[2] Pasteur,[3] Koch and Gaffky,[4] from 1871–1880, all wrote extensively relative to it, identifying the causative factor, to which was given the name of "vibrion septique." But it was not until 1891 that Welch,[5] and later Fraenkel [6] isolated from the human blood the bacillus which bears the former's name. A most important contribution to this subject was made in 1912 by Cramp,[7] but his deductions, made from an extended series of cases, were either not appreciated or have been forgotten, nor has reference been made

by subsequent authors to this most excellent article. With the statements and conclusions made by him, the observations recorded in the present paper are in close accord.

The pathology of gas gangrene is not particularly difficult to appreciate, but upon this knowledge rests the decision of the degree and extent of surgical interference, and the nature of the post-operative treatment.

The development of this condition is particularly invited by a massive bruising of tissue such as that received from high explosives in which also

FIG. 2.—Same arm as seen in FIG. 1. After five days treatment showed sterile smears, no œdema, secondary suture.

infected clothing is carried directly into the depths of the wound where anaërobic conditions and a perfect media are immediately found, or in crushing compound fractures. In these osteo-muscular wounds infection by anaërobic bacteria becomes imminent between the seventh and eleventh hours after reception of the wound, while the aërobic germs will not become established before the eighteenth to forty-eighth hour, as determined by Sacquépée. There is therefore within the first twelve hours inaugurated the *first stage* of gas gangrene, that of anaërobic infection, located as yet only in the superficial bruised and devitalized tissues. There has as yet been no ocular evidence such as skin discoloration or crepitation. This stage passes quickly into the *second*, characterized by the local gangrene of muscle, and is particularly rapid in development if there has been any marked interference with the blood supply, as might be occasioned by the injudicious employment of a tourniquet. The gas is now rapidly formed, and causes a local œdema from its toxic products.

This causes separation of the individual muscle fibres and compression of the adjacent blood-vessels, as evidenced by the blanching of the parts affected, which serves to cause an anæmia of other muscles, and makes them immediately susceptible to a continuance and spread of the infection and the development of the *third stage* of massive gangrene.

The patients usually present a markedly toxæmic state, believed by some to be a condition of acidosis, whether the result of the toxins elaborated by the bacteria *per se* or developed from their by-products, has not yet been deter-

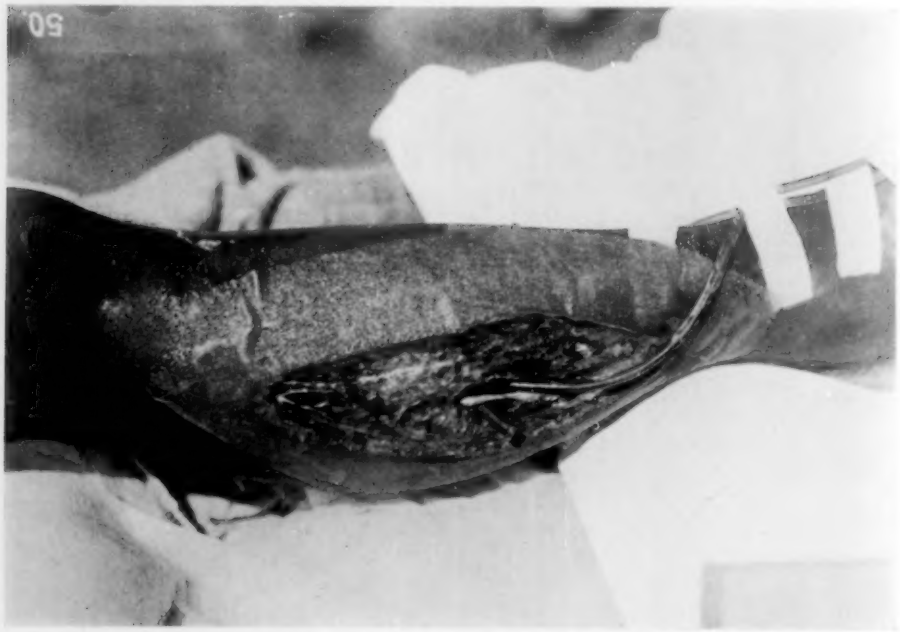

FIG. 3.—Gas gangrene of leg involving two fascial planes showing area of primary débridement, the retracted wound edges due to distention by œdematous and infected muscles, and the extension of incision beyond the area of blanched and œdematous skin.

mined. Certainly the gas formed is not responsible, as it is probably quite innocuous and acts only as a compressive and mechanical agent to promote further advance of the infective process. Bull and Pritchett believe that there is a soluble chemical substance which is absorbed, which occasions the toxic symptoms, and they developed an antitoxin from the bacillus Welchii, which is claimed not only to be a preventive but a direct ameliorating agent against the development of gas gangrene. Certainly there are many observations recorded which substantiate this view. The very practical applicability of its use in civil surgery will be shown later.

Considering therefore the above pathology, there are several things which are indicated according to the site and nature of the lesion and the stage of development at which it is first seen.

I. Cases of the first class, where as yet the infection is purely local and in the superficial tissues, and where there has not been any gas formation or

external evidence of gangrene, present only the characteristic odor. In these the entire area of devitalized tissue should be resected and the wound left widely open. Packing it or in any way interfering with the blood supply predisposes to a continuance of the infection and rapid spread to adjacent muscles. In many hundred cases we have separated the tissues with a layer of gauze and thoroughly tubed all areas with Carrel tubing, instilling hourly quinoformol solution, which has resulted in actual sterilization of the wound in repeated instances, in forty-eight to seventy-two hours, allowing a secondary

FIG. 4.—Internal aspect of leg shown in Fig. 3. Showing through and through drainage with large fenestrated tube and Carrel tubes through which solution is instilled passing to either side of fascial planes.

closure within the first week. The results of such a procedure are shown in Figs. 1 and 2.

II. The infection having passed the stage of simple anaërobic contamination, it rapidly goes on to that of definite gangrene of the muscle, with the concomitant formation of gas and a marked degree of swelling of the part affected, which is very characteristic, quite out of proportion to the apparent degree of infection, and a rapidly developing ischemia—at first distal to but quickly extending above the gangrenous area. The skin is tense and whitened and feels brawny, a material length of time before crepitation can be elicited.

Appreciating the pathology that the infection travels longitudinally in the muscle and with difficulty passes to an adjacent one through its sheath, unless a massive anæmia is occasioned by an injury to a large arterial trunk, and that the swelling is due to gas pressure from within and toxic irritation, that the ischemia is due to direct collapse of the blood-vessel walls the result of this pressure, the indications are quite evident. Resect the entire muscle involved

or at least well into viable tissue, readily recognized by color, contractility and bleeding. Incise the skin in its longitudinal axis through the underlying fascial planes, thoroughly tube beneath skin and between muscle planes and instill with an adequate germicidal solution as previously directed; carry superficial incisions through the border of the blanched skin into healthy and bleeding tissues (Figs. 3 and 4). The fear of infecting normal tissues appears negligible, as the exposure and antiseptic inundation apparently precludes it.

III. When the case is seen late, or has been inadequately treated, there

FIG. 5.—Extensive gas gangrene of leg showing large area of gangrenous skin removed and underlying areas of débrided tissues. Large tubes also passed beneath soleus to opposite aspect of leg.

develops the *massive gangrene* or terminal stage. The skin changes from a white to a dirty grayish-green color—subcutaneous crepitation is present, blebs containing a sero-sanguineous exudate appear. The distal pulse has disappeared. The patient is profoundly toxic. Immediate liberation of all the areas involved is imperatively necessary. The preservation of anatomical structure is to a large degree to be disregarded. The parts must be widely and extensively opened up (Figs. 5 and 6)—their reconstruction can be accomplished later. The question of amputation is a pertinent one. Many of these cases could not withstand the shock of one. An extended observation assures me that the more conservative treatment has resulted in not only saving life but of giving the patient a limb which may be made considerable use of when reconstructed. The absorption of toxins must be stopped, however, and it is only a question of judgment based on experience which will decide whether the limb should be sacrificed or not.

In all cases of gas gangrene, no matter in what stage they may be seen, prompt and energetic use of *perfringens* antitoxin should be immediately instituted and persevered in. We have, in New York, available only the mixed *perfringens* and tetanus antitoxin of the Lederle Antitoxin Laboratories from which encouraging results have been obtained by various observers. It is somewhat difficult to obtain, however, and is quite expensive.

FIG. 6.—Gas gangrene of left shoulder involving joint, showing method of deep drainage and instillation and herniated œdematous and infected muscle, recovering without amputation.

Two interesting phenomena are to be noted in a large majority of cases of gas gangrene. First, the temperature is, as a rule, comparatively low and out of proportion to the rise in the pulse. This becomes more marked the farther advanced the condition is. Second, the degree of pain is apparently out of all proportion to the lesion. Taken in conjunction, both factors may be of aid in diagnosis.

Infection with bacillus Welchii, however, may occur elsewhere in the body, where it was not the result of compound fractures or crushing accidents. The observations of Jennings relative to the rôle played by this bacillus in cases of gangrenous appendicitis are of very actual interest and coupled with the observations on the same subject by Flexner, Veillon and Zuber, Dudgeon and Sargent, Lanz and Tavel, Runeberg, Heyde, Grigoroff and Simonds, warrant the conclusion that the bacillus Welchii occur with greater frequency in cases of gangrenous appendicitis than in ordinary inflammations, usually in conjunction with numerous other organisms. Jennings, therefore, makes it a practice in his clinic to add to the surgical treatment of these cases,

the benefit felt to be derived from the administration of a mixed antitoxin of *perfringens* and *tetanus* which he thinks has proven of very material benefit.

If also a condition of acidosis is present, this should be combated by sodium bicarbonate, either by mouth, by rectum or intravenously. It is certainly a point that should not be overlooked.

The writer's first experiences with any considerable number of these infections occurred in the summer of 1918, when detailed to the American Red Cross Hospital No. 5, situated at Auteuil in the suburbs of Paris, to which

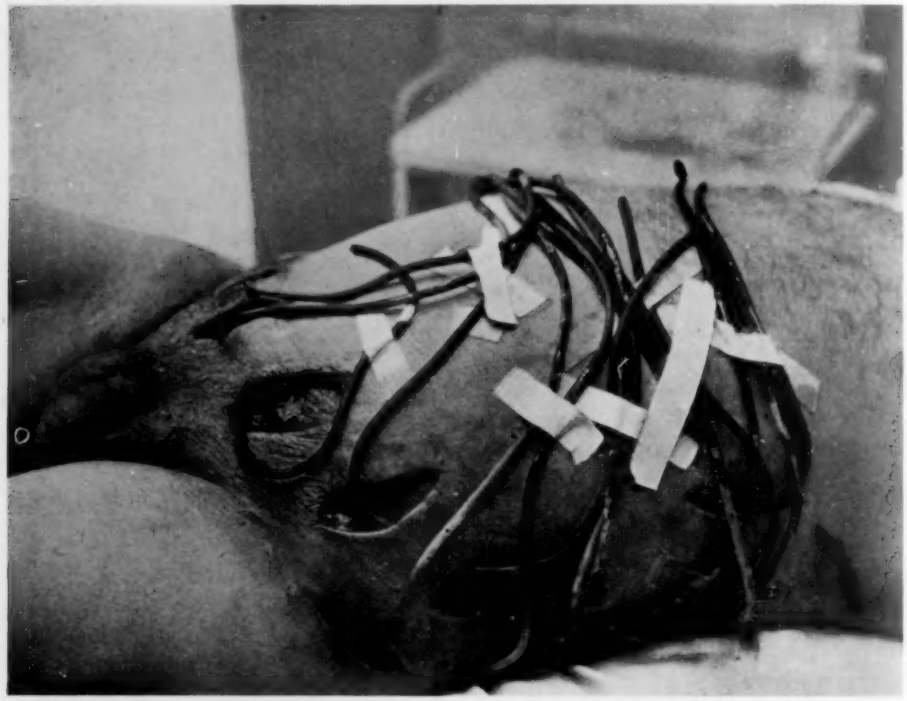

FIG. 7.—Gas gangrene involving perineum, scrotum, wall of abdomen and thorax; showing terracing of incisions from left axilla down and across suprapubic region to right iliac crest, with tubing for instillation *in situ*. (Taken after subsidence of infective process.)

hospital men were being evacuated from the action at Chateau Thierry. During the height of this crisis, their movement was necessarily delayed, so that many cases had already advanced well into the second class of gas gangrene infection before their arrival at the base. Here were being cared for between fifteen hundred and two thousand severely wounded soldiers, mostly marines. It was early apparent that, although the Carrel-Dakin treatment was being most painstakingly carried out under the direction of Major Tarnowsky, Chief of the Surgical Service, there were certain pathologic and mechanical conditions which were not adequately met by its use, so that frequent amputation had to be resorted to. These defects were apparently that it had no effect on the more deeply infiltrated structures, that the adjacent and dangerous œdema was not lessened nor was there any diminution of the gas which had already been evolved which was causing the distal ischemia and

intolerable pain by pressure on the neuro-vascular system, and therefore favored a continuance of the process and allowed the establishment of the later stages of gangrene which necessitated subsequent amputation. In addition the solution was unstable, difficult of preparation and standardization.

FIG. 8.—Showing amount of scrotum ablated. Both testicles hanging free. Complete destruction of perineal structures down to urethral musculature. Crescentic incisions overlying, and down to both ischial tuberosities with radiating incisions to external anal sphincter. (Taken after subsidence of infective process.)

It was also irritating, necessitating protection of the skin edges with vaselined gauze.

It was evident that a solution that would tend to rapidly relieve the tense and engorged tissues and at the same time act as a bactericide would be more suitable for immediate use after surgical débridement. Following the ideas of Colonel Wright as to the effect of hypertonic salt solutions, and that of

Major Taylor as to the value of solutions of quinine and acetic acid to promote an analgesic effect upon the exposed surfaces as well as for its germicidal properties, an increased favorable action, it was thought, might be secured if to these a certain percentage of formol, alcohol and thymol be added—the first for its bactericidal and fixing properties, synergised by the alcohol necessary to get the thymol into solution.

After various experiments made with the consent and coöperation of Major Tarnowsky, the following was determined upon:

Quinine sulphate	1 gm.
Hydrochloric acid	.50 c.c.
Glacial acetic acid (99 per cent.)	5.00 c.c.
Sodium chloride	17.50 gm.
Formol (40 per cent.)	1.00 c.c.
Thymol	.25 gm.
Alcohol (90 per cent.)	15.00 c.c.
Aqua q.s.ad	1 litre

compounded by dissolving the quinine in the hydrochloric and acetic acids. (2) Dissolving the sodium chloride in the water. (3) Dissolving the thymol in the alcohol. Add No. 1 and No. 2, then the formol, and finally the thymol solution.

This solution was immediately employed in a series of one hundred severely infected cases which had been treated with Dakin's solution for ten days or longer without any appreciable signs of diminution in the local inflammatory condition or in the lessening of the bacterial flora present. This series comprised the following conditions:

Compound Comminuted Fractures

Femur	18
Humerus	11
Tibia	11
Fibula	3
Astragalus	1
Tarsal bones	2
Metatarsal bones	1
Patella	6
Acromion	2
Scapula	1
Radius	2
Ulna	3
Skull	1
Pelvis	1
Ribs	1
Osteo-arthritis of the knee-joint (gunshot wounds)	8

Perforating Gunshot Wounds With Foreign Bodies

Thigh	10
Leg	5
Abdomen	2
Chest	2
Arm	4
Neck	1

Amputations for Gas Gangrene Following Gunshot Wounds

Leg	3
Arm	1
Total	100

Many similar cases had previously resulted in amputation, and it was a fair inference that some at least of these would need amputation as the natural course of events. This procedure was not necessitated, however, in any of the cases after the institution of the above solution, which was applied exactly as the Dakin had been. Of course the most thorough and painstaking surgical mobilization of the infected tissues according to recognized surgical principles is necessary before the instillation of this chemico-mechanical solution. The results obtained apparently justified its use. It appeared quite actively inhibitive and destructive to both aërobic and anaërobic bacteria, was quite unirritating, perfectly stable, easy of preparation and mildly deodorant. By the definite flow of fluids from the tissues into the wound which it caused, a rapid reduction of the œdema and cessation of pain resulted.

The solution, however, possesses no proteolytic property, and when the infective process had been checked, recourse was then made to Dakin's solution which proved most effectual, as is well known, in removing the detritus and slough. This lack of proteolysis is however a very definite adjunct, as preventive of secondary hemorrhage, many serious and several fatal cases of which had previously occurred. No such accident occurred after the beginning of the use of the quino-formol solution. These results were at the time made the subject of a preliminary report which was published in the ANNALS OF SURGERY of November, 1918.

The general morale in the wards in which this treatment was applied was notably different from those in which Dakin's alone was continued—due possibly to the lessened absorption of toxic material and the uniform drop in temperature which attended its administration as well as to the decrease in the skin irritation previously experienced. There had developed a very definite depressive psychosis in these men due to the wounded having so often seen their companions suffer progressive gangrene resulting in ultimate amputation. This depression was now practically overcome, and tales of former gloomy experiences were no longer poured into the ears of the newly arrived recently wounded. This unquestionably resulted in a material shortening of their convalescence and an earlier return of their mental equilibrium which had noticeably been impaired by the shock of their wounds, and later exposure and final operative repair, with incident toxæmia. It seemed an ideal adjuvant in the early and immediate treatment of these infected wounds and particularly suitable for use in the zone of the advance because of its stability, non-irritability, ease of preparation, simplicity of ingredients and feasibility of concentration.

Since those Auteuil days it has been used with equally beneficial results in a great variety of conditions. Stone reports better results with it in a large

series of empyemas than he was able to obtain in controls on which Dakin's was employed. Captain Fauntleroy, U. S. N., states that it has proven of the utmost service in the treatment of very extensive burns with large areas of sloughs, such as occur in severe scalds, in which class of cases he has had an extensive experience.

Personally we have used it in the treatment of carbuncles, impetigo, and in all instances of lymphadenitis, cellulitis and phlebitis where its peculiar properties are almost immediately apparent. Two widely opened knee-joints,

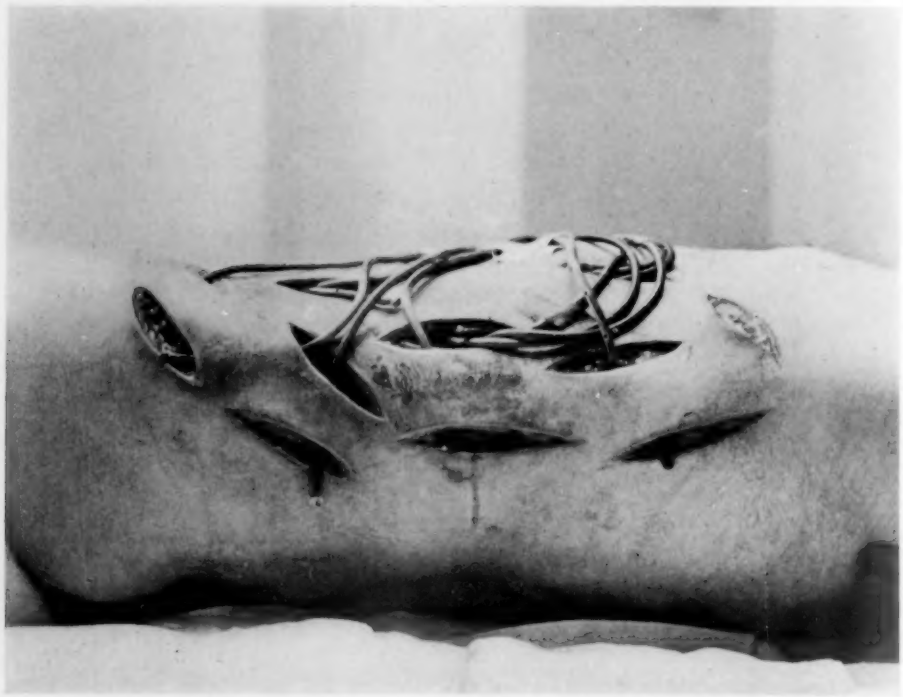

FIG. 9.—Wounds clean; sloughs of tissue underlying skin-bridges being cleared by Dakin's.

primarily infected but treated immediately, were closed after forty-eight hours and immediately mobilized. It makes an ideal immediate treatment of a mangled infected hand or limb resulting from industrial or other accident.

As exemplifying all of the points mentioned in the body of this paper, illustrating most vividly the ruthless destructiveness of the infection and the possibilities of checking its advance and limiting its effects by prompt radical measures, the subjoined case-report is worthy of record. That a recovery should have been secured in the circumstances of this case is notable since in the literature there are recorded only two instances of gas gangrene in a similar situation (Thibaut-Schulmann [10] and Berkow-Tolk [11]) both of which resulted fatally.

CASE REPORT.—October 30, 1921, a man, aged fifty-nine years, referred by Dr. Nathanial Thayer, was received into hospital with the history that he had been in good health until five days before admission, when a general malaise attended with chilly

sensation had developed; temperature 103° F. The following day his temperature remained elevated and he noted what was thought to be a moderately inflamed hemorrhoid for the relief of which local applications were made. The following day the inflammation had spread anteriorly into the perineum, causing slight swelling on either side of the scrotal perineal junction. By the next day the scrotum had become swollen and reddened and a small necrotic spot had appeared in the most dependent part. The next day (that previous to being seen) the scrotal swelling became very marked and the adjacent swelling had extended above Poupart's ligaments on both sides. The necrotic spot on the scrotum had markedly increased in size.

When seen the following day, October 30, 1921, the scrotum was greatly distended

FIG. 10.—Wounds completely healed, having been approximated by undercutting and suture.

and showed an area of necrosis two and one-half inches in diameter. The perineum presented several smaller necrotic spots, all entirely black. The perineum was distended, reddened, not particularly sensitive. Patient was very toxic and apathetic; temperature 100½; pulse 106. Definite crackling on light palpation was appreciable in the involved tissues.

Operation.—Under gas oxygen anæsthesia an immediate inverted crescentic incision was made in the perineum which disclosed a typical condition of gas gangrene. The incision was carried upward through the median raphé, laying wide open the entire perineum; the lower half of the scrotum containing the area of necrosis was cut away; Carrel tubes were introduced up to the inguinal canal and continuous instillation of quino-formol solution inaugurated. Cultures showed bacillus Welchii and bacillus coli. Notwithstanding these measures, there was, during the next twenty-four hours a marked active and rapidly progressing extension of the infection; the œdema and gas formation spread up over the pubes, up the entire left side to the tenth rib and to the crest of the ilium on the right side. The patient's condition was critical. Eight free incisions, each three and one-half inches long, were made from the upper and outer margins of the

swollen tissues extending obliquely downward across the suprapubic region to the right anterior superior spine (Fig. 7). These liberated moderate quantities of very thin sero pus and gas. Evidences of fascial necrosis were already present. All the incisions were joined subcutaneously and Carrel and fenestrated large tubes introduced between each wound. Temperature 100; pulse 95.

Thirty-six hours later the inflammatory zone had extended into the left flank and three inches upward towards the left axilla; there had also developed marked swelling and tension surrounding the anus and extending to the tuberosities of the ischium. Further multiple incisions were made over the chest and in the flanks. Two crescentic incisions were then made extending from the perineum posteriorly over and down to each tuberosity of the ischium. Radiating but not joining incisions were made within this circle to the limits of the external rectal sphincter (Fig. 8) with liberation of much pus and necrotic material. The instillations of quino-formol solution were alternated every hour with lavage of each wound through the tubes with a thirty per cent. solution of hydrogen peroxide and half hourly introduction of a stream of oxygen. A definite acidosis had developed and dram doses of sodium bicarbonate were given hourly by mouth.

FIG. 11.—Showing extent of suprapubic incisions and their healing by granulation.

On November 2, intravenous injections of 100 c.c. of *perfringens-tetanus* antitoxin were begun; they were repeated in twelve hours; four other injections were administered during the following forty-eight hours. After the third injection the patient's condition was markedly better; he was much brighter, and he was able to drink freely and to take nourishment for the first time since his admission.

Each dressing of this case took between one and two hours, and great quantities of necrotic sloughs were continually removed.

On the twelfth day, after a particularly extensive removal of necrotic tissue, there developed a septic pneumonia in the right lower lobe, due undoubtedly to a liberated thrombus. During the following six days, his condition was rather precarious, due to marked myocardial weakness.

After two weeks of unremitting treatment, the infective process having been completely controlled, the quino-formol solution was replaced by Dakin's (Fig. 9). All remaining detritus cleared up rapidly, so that the patient was really convalescent at the end of three weeks, showing no alarming effects other than a continued tachycardia of

120, and a very slow recovery of mentality. During the following six weeks a progressive general improvement was maintained.

During all this time of treatment, both testicles were hanging free, all fasciæ and enveloping tunics having been swept away, their independent distant arterial supply accounting of course for their continued viability. The rectum had prolapsed due to its supports having sloughed out.

FIG. 12.—Showing result of reconstruction of scrotum, reformation of perineum and replacement of rectum by reconstruction of anal supports. (Compare with Fig. 8.)

Plastic closures of the gaping abdominal and chest wounds were satisfactorily accomplished without tension by undercutting (Figs. 10 and 11), and on December 21, 1921, an extensive reformation of the perineum and scrotum and replacement of the rectum were satisfactorily effected, so that in two weeks time the testicles were comfortably invested, the rectum properly supported and normal control of the sphincter obtained (Fig. 12). The patient was discharged, walking, entirely well, January 23,

1922, eighty-six days after admission. His present condition is quite normal, no hernia have developed, the rectal supports have remained intact and his usual avocation has been resumed.

Although the armistice of November, 1918, at once put an end to the conditions that made the treatment of gas gangrene a matter of continuous prime importance, there still occur in civil practice, cases of gas gangrene in sufficient frequency to warrant this review of the peculiar factors involved and the rational method of treating this type of infection. In addition its applicability and favorable results in the treatment of other infections is evident.

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CRANIOTOMY UNDER LOCAL ANÆSTHESIA

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Major cranial operations had been infrequently performed under local anæsthesia until the experiences of the great war showed that extensive surgical interference upon the skull and the intracranial contents was possible without general anæsthesia. Since 1918, however, many surgeons have operated upon non-traumatic intracranial lesions after the soft tissues of the scalp had been rendered insensitive by the injection of cocain or novocain solution.

In my clinic we have performed a large variety of cranial operations under local anæsthesia—not only the minor procedures of trephining for aspiration of the brain, the division of the sensory root of the trigeminus for major ventricular cavities for ventriculography, but also for the drainage of abscess of the brain, the division of the sensory root, of the trigeminus for major neuralgia, and for the exposure and removal of intracranial tumors—endotheliomas from the surface of the cortex, subcortical growths, intrasellar and suprasellar pituitary growths, growths in the cerebellum or in a lateral recess, etc.

During the past six years, we have performed 298 major craniotomies, in 62 of which (21 per cent.) under local anæsthesia either an osteoplastic flap was made or a large amount of bone removed. The following table, which does not include operations for trigeminal neuralgia or for pituitary disease by the transphenoid route, gives the figures for the period above mentioned:

Major and Minor Cranial Operations for Suspected Tumor
October, 1918, to October, 1924

	General anæsthesia	Local anæsthesia	Total
Craniotomy, osteoplastic flap	129	59	188
Craniotomy, suboccipital	107	3	110
Craniotomy, subtemporal decompression	48	19	67
Craniotomy, minor	67	60	127
Totals	351	141	492

1. Indications for and Contraindications to the Use of Local Anæsthesia for Major Cranial Operations.—It has long been known that general anæsthesia by ether or chloroform has distinct disadvantages in major intracranial surgery. The inhalation of ether is followed by a rise of both general blood-pressure and intracranial pressure, and the amount of bleeding during the operation is distinctly increased thereby. Many years ago, Sir Victor Horsley advised that chloroform should be the anæsthetic of choice because there was less bleeding during an operation under chloroform. With careful hæmostasis

the experiences of others and our own showed that this was not a factor of great importance. Chloroform is, however, a distinct cardiac depressant, although its main effect is upon the respiratory centre. Besides, the threshold of safety of dosage is much smaller than that of ether. During ether anæsthesia, however, there is a more or less marked rise of intracranial pressure with its consequent tendency to engorgement of the intracranial veins and brain œdema.

These potential dangers have to be reckoned with in not a few patients,

FIG. 1.—Showing the location of the first injections of the local anæsthetic.

although they may be partly counteracted by posture, *i.e.*, a more or less sitting position of the patient during the operation, and by the use of concentrated solutions of sodium chloride, glucose, or magnesium sulphate.

In infiltrating tumors of the cerebral hemispheres, the use of ether as a general anæsthetic distinctly increases the dangers of the operation. Patients with this type of growth when subjected to an exploratory operation—a procedure ordinarily without great danger—sometimes never recover consciousness after the surgical interference. The fatal outcome is often due to the effect of the anæsthesia rather than to the surgical manipulations. This belief has been strengthened by the results of post-mortem examinations and by the fact that in some of these patients the operation has been terminated for the

time being after an osteoplastic flap has been raised. These patients do much better if a local anæsthetic is used.

A further advantage of local anæsthesia exists in those patients in whom the disease involves the speech area, as when a tumor is to be removed from

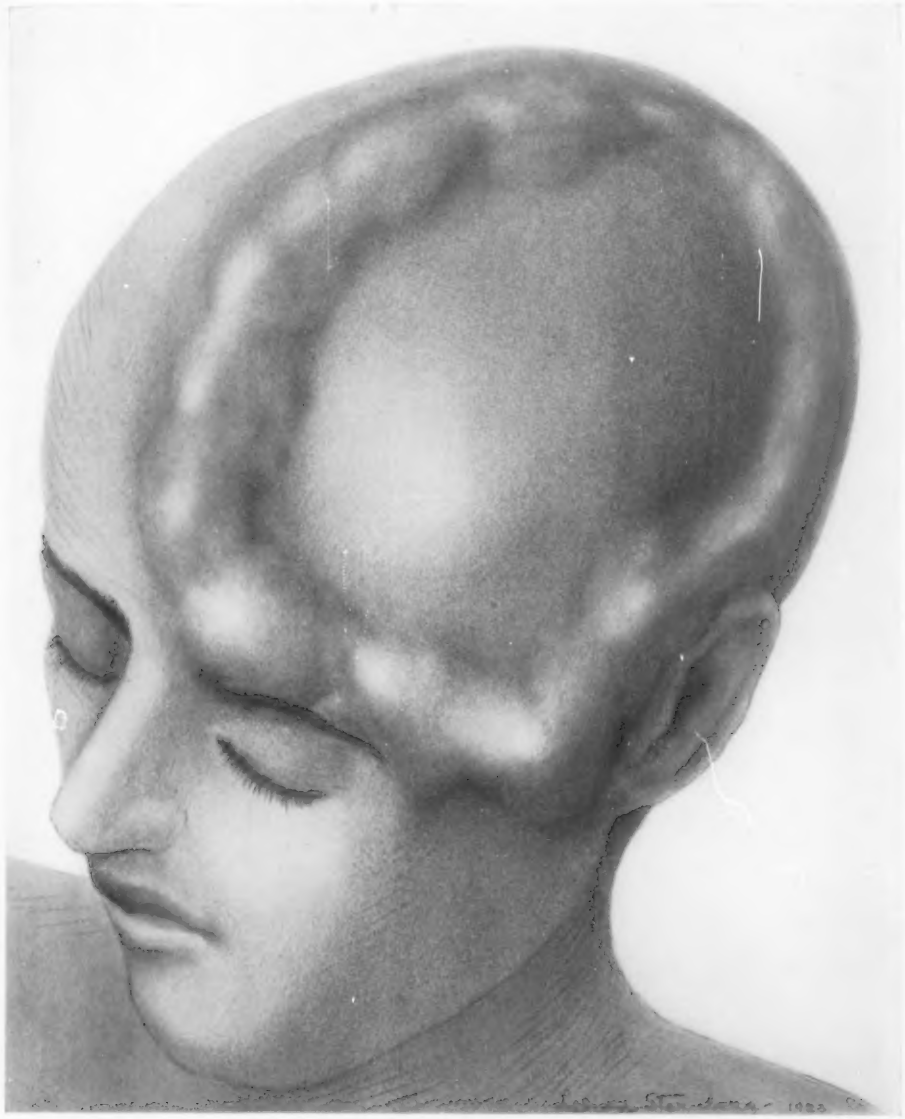

FIG. 2.—Showing the area over which the scalp and periosteum have been infiltrated with the anæsthetic solution.

the left frontal lobe. In these cases, an assistant can converse with the patient so that the operator is kept informed of the fact that the speech mechanism has not been disturbed during the surgical procedure.

A general anæsthetic is almost always required during major cranial

operations upon children, and upon nervous, restless or delirious patients. For the satisfactory carrying out of a cranial operation under local anæsthesia, the patient must be able to coöperate with the surgeon. The effects of fear and anxiety, increased by the sights and sounds of the operating room, may make

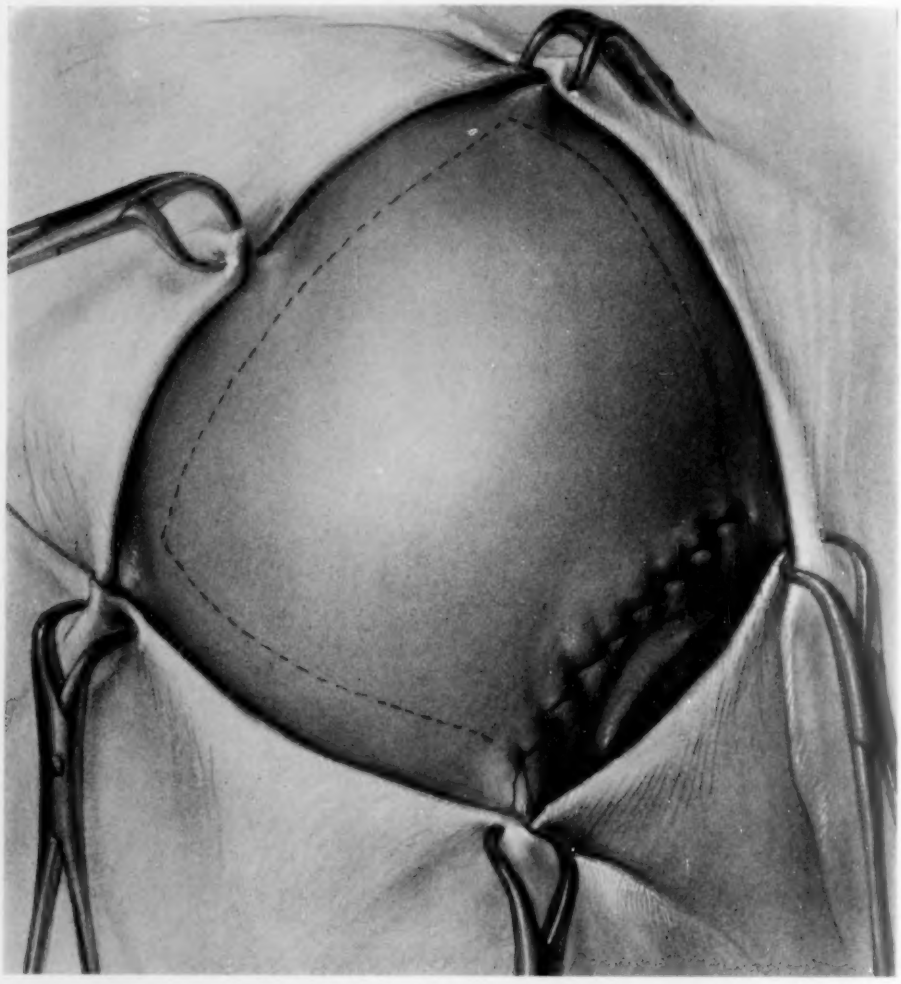

FIG. 3.—Showing the operative area prepared with the hæmostatic suture in the temporal region. The lines of incision are indicated by the broken line.

it impossible for a nervous individual to control himself during a more or less prolonged surgical procedure, and in these individuals, a general anæsthetic is necessary. It is remarkable, however, that even sensitive and high strung patients will remain quiet and thus help the surgeon, as long as they know exactly what to expect, and as long as little or no actual pain is felt.

2. The Nerve Supply of the Scalp and Skull, and the Sensitiveness of the Membranes, Brain, and Cranial Nerves.—The tissues of the scalp and the periosteum over the greater part of the convexity of the skull are supplied

by branches of the trigeminal nerves—the supraorbital and supratrochlear branches of the ophthalmic division, the zygomatic and zygomatico-temporal branches of the superior maxillary, and the auriculo-temporal branches of the mandibular division. In the occipital regions, the nerve supply comes from

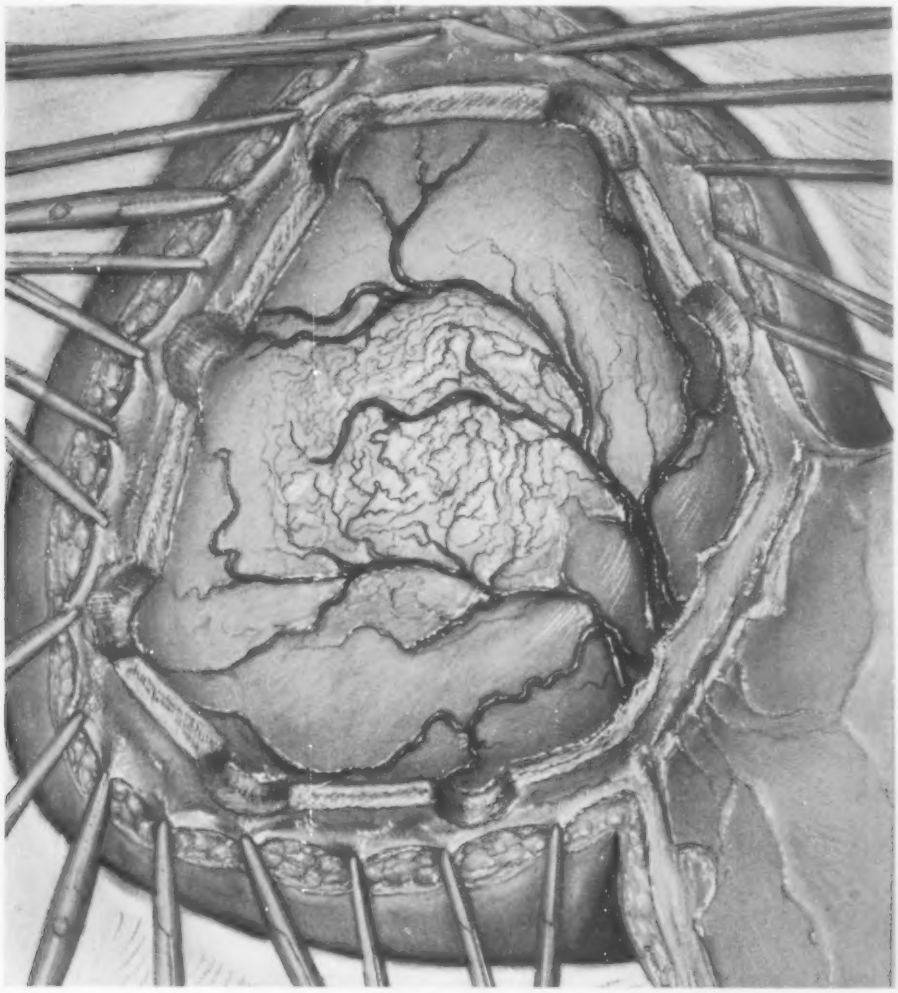

FIG. 4.—The bone flap has been turned down and a vascular area of the dura overlying an endothelioma, has been exposed.

the great occipital from the dorsal division of the second cervical nerve, and the small occipital from an ascending branch of the cervical plexus.

For local anæsthesia purposes, the supraorbital and supratrochlear nerves can be easily reached by the needle near their foramin of exit from the skull, or a little higher, where these nerves pass upwards and backwards underneath the orbicularis and frontalis muscles.

The zygomatico-temporal branches can be reached by an injection of the

anæsthetic into the anterior part of the temporal fossa, the needle being passed through the temporal muscle.

The auriculo-temporal nerve can be reached by an injection just behind the base of the zygoma and posterior to the course of the temporal vessels, and the great occipital, by an injection at a point about two-thirds of the distance from the external auditory meatus to the external occipital protuberance.

FIG. 5.—A dural flap has been reflected and the tumor exposed. Note that a piece of dura adherent to the tumor is excised with the growth.

The nerve supply of the bones of the skull is, in general, derived from the same sources as that of the soft tissues of the pericranium. If the nerves to the scalp have been blocked by a local anæsthetic, the bone is rendered insensitive and the primary trephine openings can be made and the bone cut between them without causing pain.

The inner table of the skull has no periosteum, and is supposed to be supplied by nerves derived from the outer layer of the dura, although these nerve branches have not been satisfactorily demonstrated.

Little is known regarding the nerves of the cerebral envelopes. The text-

books usually state that the dura contains fine nerve filaments derived from the trigeminus, vagus and hypoglossal (through the first and second cervical), and from the sympathetic nerves. It is probable that the nerves in the dura supply, in the main, the blood-vessels which run in its outer layer. The claim has been made that there are fine nerve fibres in the pia and arachnoid, but this has not been satisfactorily substantiated.

When the dura has been exposed in the course of a craniotomy under local anæsthesia, the membrane can be handled and incised without any evidence

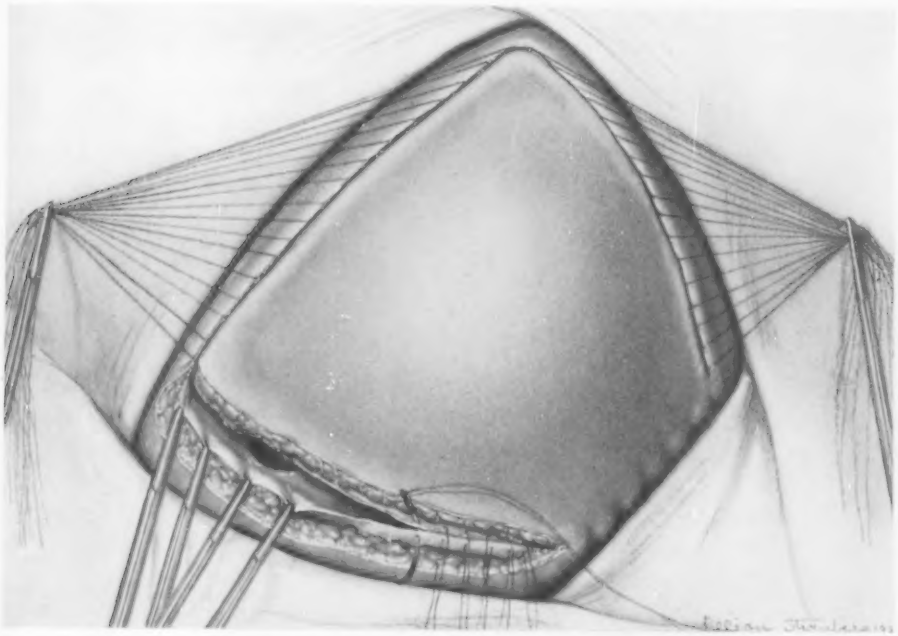

FIG. 6.—The method of suturing the galea by interrupted stitches of fine silk.

of pain or any other sensation from the patient, and the membrane will be found to be insensitive no matter how far distant from the exposed area it is manipulated. In many of our operations under local anæsthesia, I have explored and handled the inner surface of the dura over a large area, and the patients never gave any evidence that they felt sensation of any kind.

Occasionally, however, when the dura is separated from the bone in the subtemporal region, there was some pain which seemed to be caused at the time when the region of the meningeal vessels was being manipulated. In the course of a transfrontal craniotomy for the exposure of pituitary tumor, I have, in several instances, found a small area of dura, at the base of the anterior clinoid processes which seemed to be very sensitive. When this area was touched with a probe or other metal instrument, the patient complained of a burning sensation referred to the eyeball of the same side. The dura near the margin of the foramen ovale also seems to be endowed with sensation.

although the pain that was complained of may well have been due to an irritation of part of the third branch of the trigeminal nerve.

Lennander, Meltzer and others many years ago, investigated the sensitiveness of the peritoneum, and suggested that the lack of sensibility in the parietal peritoneum might be an effect of the exposure of that membrane. A similar argument might be made with reference to the dura, although it is difficult to believe that this is the case.

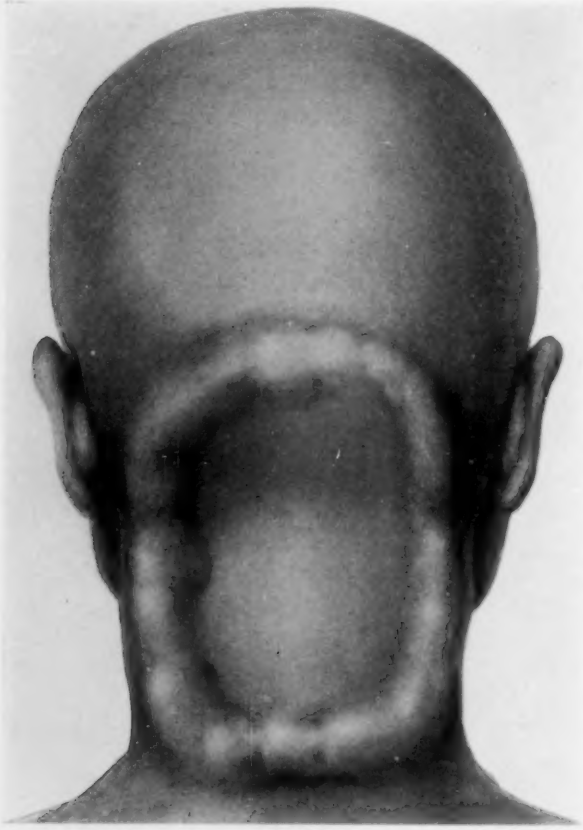

FIG. 7.—The area of infiltration with the local anæsthetic for a suboccipital craniotomy.

As is well known, the brain when exposed at an operation, is insensitive. It can be punctured with a needle, incised with scalpel or scissors, and pressed upon or drawn aside by retractors. When, however, considerable pressure is made in the direction of the optic thalmus, the patient will often complain of pain which he is unable to localize. Not so rarely, also, when the ventricles are being emptied of fluid, or while air is being injected for the purpose of ventriculography, the patient will complain of headache which he is unable to localize to any part of the head and which disappears within a few moments. This may occur especially if the ventricular fluid is escaping too quickly or if the air is injected too rapidly, and after considerable fluid has been removed, or when already the ventricles contain considerable air.

3. The Technic of Local Anæsthesia for Osteoplastic Craniotomy.—A few of our patients received a small dose of morphine before the operation, but in the larger number, no morphine was administered: As a local anæsthetic we generally use a novocain-adrenalin solution, and of this a one per cent. solution of novocain with 1-1000 of adrenalin is injected around the main nerve trunks and one-half per cent. solution for the general infiltration anæsthesia. The addition of adrenalin to the novocain has both advantages and disadvantages. The adrenalin diminishes general oozing from the scalp and prolongs the effect

of the local anæsthetic. On the other hand, there is a slightly increased tendency to a local post-operative oozing of blood from the cut edges of the scalp. All in all, however, the advantages of adrenalin outweigh the disadvantages.

The injections are made with a stout record syringe and short needle, and the injection is made by finger pressure or by one of the compression devices, although no very satisfactory one has as yet been devised.

The needle is first entered just over the root of the nose, and sufficient of the one per cent. novocain is injected both intracutaneously and deeply under the periosteum to form a good sized wheal. A second puncture and injection is made above the eyebrow, near the outer end of the supra-orbital ridge; a third injection deeply into the temporal fossa just behind the malar bone; a fourth, deeply into the temporal fossa above the zygoma and in front of the ear; and a fifth behind the auricle in the general location of the point of exit from the bone of the great occipital nerve (Fig. 1).

A longer needle is then attached to the syringe,

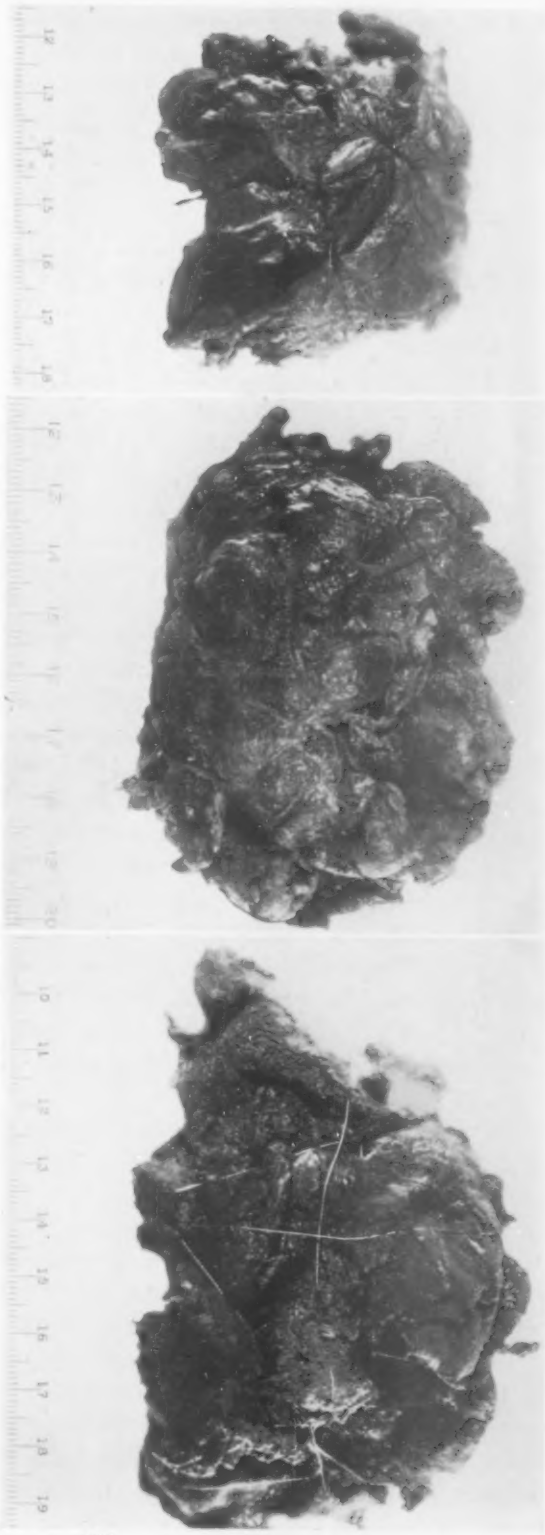

FIG. 8.—Large brain tumors removed under local anæsthesia.

and the scalp infiltrated with one-half per cent. novocain-adrenalin solution along lines which connect each one of the points which were first injected. The posterior line will vary somewhat with the location of the bone flap that is to be made, but it is always advisable to include a larger area rather than a smaller one. The line of injection above should always run well beyond the mid-sagittal line, and in most instances, should run along a line three to four centimetres from the middle of the vertex (Fig. 2).

After the scalp has been infiltrated with the solution, a second series of injections should be given in which the needle is passed through the periosteum until it strikes the bone, and the injection given all around underneath the periosteum.

By this method, an area which included the greater part of one-half of the skull is rendered anæsthetic, within which area the scalp is to be incised, the primary trephine openings made, and the bone between them divided with a Gigli saw. Various steps of the procedure are shown in Figs. 3 to 6.

After the anæsthetic solution has been injected, fifteen to twenty minutes should be allowed to elapse before the actual operation is begun. By that time the wheals caused by the injections have flattened out and the anæsthesia of the entire area is complete.

Especial care must be taken to thoroughly anæsthetize the skin and muscles just above the zygoma; if this is not done, the patient may feel some pain when the flap is broken at its base in the temporal region.

In those patients in whom a subtemporal decompression is to be performed or the division of the sensory root of the trigeminus for neuralgia, the area to be anæsthetized is, of course, much smaller, while in those in whom only a small trephine opening is to be made for aspiration of the ventricles, for air injections, for pneumography, and for aspiration of the brain for suspected brain abscess, only a small line of the soft tissues of the scalp need be anæsthetized.

I have, in several instances, performed a suboccipital craniotomy under local anæsthesia for tumor of the cerebellum or of the lateral recess. However, the patient in whom this is attempted, must be one who can be depended upon so that he does not move his head while the cerebellum is being retracted. In these patients, I have infiltrated the tissues of the scalp and of the neck along the lines shown in Fig. 7, especial care being taken to anæsthetize the suboccipital nerves, and to thoroughly infiltrate the tissues at the root of the neck.

In properly selected cases the exposure and removal under local anæsthesia, of tumors of the brain can be very satisfactorily and painlessly accomplished. It is possible to remove not only small growths, but even very large ones, as Fig. 8 shows. In the proper cases, the dangers of the operation can be lessened by the use of a local anæsthetic.

Recovery after cranial operations under local anæsthesia is apt to be a smooth and uncomplicated one, as the nausea and vomiting which so often follows a general anæsthesia, is avoided and the nourishment of the patient can be begun soon after the surgical procedure has been completed.

THE DIAGNOSIS AND LOCALIZATION OF SPINAL CORD TUMORS

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Surgery produces few results more brilliant than the restoration of function following the extirpation of spinal cord tumors. Although the only possibility of a cure to patients so afflicted is by total removal of the neoplasm, defects in the methods of diagnosis and localization have, until recently, withheld from many the fruits of operative procedures. Fortunately, these deficiencies have so far been overcome that it now seems possible not only to diagnose and accurately localize every spinal cord tumor, but also to confidently exclude tumors in the differential diagnosis. These advances make possible precise surgical treatment for tumors and they eliminate exploratory laminectomies when the lesion is not a tumor.

Until Froin's [1] discovery (1903) that a yellow heavy albumen cloud—"Xanthochromie et coagulation massive"—was a sign of spinal compression, the diagnosis and localization of spinal cord tumors was made solely upon a careful history and neurological examination. Froin's syndrome was the beginning of a series of important chemical, microscopic, hydrostatic, and hydrodynamic tests of the spinal fluid, of punctures other than the routine lumbar puncture, and finally of mechanical aids by injections of extraneous materials into the spinal canal.

Soon after Froin's discovery it was found that a very slight increase of protein in the spinal fluid, often so slight as to be demonstrable only by delicate chemical reactions, was nearly as significant as the heavier cloud of Froin's syndrome. But neither an increase in globulin nor the presence of xanthochromie is pathognomonic of a spinal cord tumor, for both are often present in other lesions of the spinal cord and in many intracranial lesions including tumors. An increased globulin content of spinal fluid, therefore, only indicates a lesion of the central nervous system and is of no localizing importance.

Another method advanced by Pierre Marie, Foix, and Robert [2] (1913) made it possible not only to eliminate intracranial tumors, but also to localize tumors of the spinal cord within certain rather wide limits. They introduced *double* spinal punctures. Carefully examining the cerebrospinal fluid from each of these punctures, they discovered qualitative differences in the spinal fluid above and below a tumor—"l'hyperalbuminose, presque nulle dans le liquide supérieur, était au contraire considérable dans le liquide inférieur." But punctures of the spinal canal above the cauda equina carry such obvious potentialities of harm that they have never become more than locally popular. Moreover, only by chance or by repeated punctures could a tumor be localized with even a fair degree of accuracy. The introduction of the cisternal puncture in animals by Wegeforth, Ayer and Essick [3] (1919) opened up this field

of study anew. Ayer [4] (1920) soon made clinical application of the cisternal puncture, and in a large series of spinal cord lesions, with and without a block of the spinal canal, used the cisternal puncture in combination with lumbar punctures. He verified and greatly amplified the findings of Marie, Foix and Robert in painstaking studies of the fluids above and below tumors. Though seemingly dangerous, this brilliant method has been shown by the reports of cases now in the thousands to be quite safe, at least in competent hands.

FIG. 1.—Hemi-cylinder of bone removed from lumbar canal between pia and dura. Five years previously a similar tumor was removed in the thoracic canal and beginning at the upper level of this tumor. It will be noted that there are articulations in this bone; these were not present in the tumor of the thoracic region.

Ayer also made use of an even more important test in connection with these double punctures, namely the differences in the pressure of the spinal fluid above and below the spinal block. At the cisterna magna the pressure of the cerebrospinal fluid was always higher than at the lumbar canal when there was a complete block between these two points of puncture; but these pressures were always identical when the spinal canal was not occluded. For example, when the intracranial pressure is artificially raised by venous congestion resulting from compression of the jugular veins, the cisternal pressure (being the intracranial pressure) was instantly raised to a much higher level and as quickly subsided when the jugular compression was released. During the same test the lumbar spinal pressure would rise to an equal height if there was no intervening obstruction, but a block in the spinal canal above the lumbar puncture would prevent the transmission of the increased intracranial pressure to the lumbar puncture and its level would remain practically unchanged.

Antedating the studies of Ayer, and appearing shortly after those of Marie, Foix, Robert and Bouttier,[5] was the method of Queckenstedt [6] (1916). Using lumbar punctures alone, he first observed that the pressure in the lumbar canal rose following compression of both jugular veins when there was no obstruction in the spinal canal, but that the spinal pressure did not materially change when an obstruction existed in the canal. This test is very much simpler than the methods of Marie, Foix and Robert and of Ayer and gives as much information of practical value. By obtaining all the available data from the use of Queckenstedt's method, *i.e.*, chemical, microscopic examination of the spinal fluid, together with the hydrostatic and hydrodynamic studies, it has been claimed that it is possible to obtain all the information necessary to diagnose or eliminate a total block of the spinal subarachnoid space. There are, however, tumors—as I shall show—with only partial closure of the spinal canal and which escape detection by Queckenstedt's test; but for the same reason they will also be missed by the other procedures mentioned.

The surgical treatment of spinal cord tumors demands both a correct diagnosis and a precise localization, but by none of the above methods can a localization be obtained. With this problem in mind, the author [7] conceived the idea of replacing some of the cerebrospinal fluid by something which would cast a shadow in the X-ray. The delicate spinal cord would not tolerate any of the röntgenologically opaque solutions which were used at that time for the diagnosis of urological lesions. Air (including other gases) then seemed to be the only solution of the problem—it was readily absorbed and had possibilities of shadow production because its density was less than the cerebrospinal fluid which it replaced, the spinal cord, and the tumor to which it was brought into juxtaposition. It was hoped that the upper level of air would define the lower level of tumors or other obstructions in the spinal canal, and that the presence of air in the cranial chamber would eliminate a tumor with certainty.

FIG. 2.—Endothelioma apparently arising from the pia-arachnoid showing a nerve root running over its surface.

At that time it was shown (1) that the spinal cord could be thrown in relief by the surrounding column of air; (2) that obstructions in the cisterna pontis could be precisely located, and (3) in one case a tumor of the spinal cord was strongly suspected but eliminated by the air test—operation subsequently showing the lesion to be a constriction of the cord resulting from an old inflammation. The paucity of material at that time prevented the actual demonstration of a tumor localization for which the method was intended. Soon thereafter, Wideroe [8] (1921) and Jacobeus [9] (1921) located spinal cord tumors by this method, though the shadows were rather vague and looked upon as easily susceptible of erroneous interpretation.

This communication was originally intended to present the results obtained from a series of intraspinous injections of air, but the brilliant discovery of Sicard [10] makes necessary a reconsideration of the entire subject. What seemed impossible has been accomplished. Sicard has discovered and utilized an oil (lipiodol) which holds sufficient iodine in suspension to cast a heavy shadow in the X-ray. Lipiodol can be injected into the spinal canal without pain either immediately or subsequently, and apparently without any harmful effect. The oil can be made to gravitate to the tumor's level where its röntgenographic shadow will mark the tumor's location. A detracting feature is that the oil remains indefinitely in the spinal canal, but Sicard's reports lead us to believe that this prolonged stay is not harmful.

From a careful analysis of our series of spinal cord tumors during recent years, I have attempted to estimate the relative importance of these accessory diagnostic aids; in how many cases a careful neurological examination will fail to give all the information necessary both for diagnosis and localization; and, when necessary, which tests are advisable. I have included in this survey a brief account of the tumors and the operative results.

There are 36 consecutive cases of spinal cord tumors in this series; all, with two exceptions, have been verified by operation during the past six years. The exceptions were a gumma diagnosed by clinical tests and cured by antisyphilitic therapy, and a high cervical tumor which was found at necropsy. Included under the broad designation of tumor are chronic inflammatory lesions which, by their steady growth and tumor formation, give symptoms similar to those of true neoplasms; and they demand the same treatment.

THE PATHOLOGY OF SPINAL CORD TUMORS

There is no single satisfactory method by which tumors of the spinal cord can be grouped—a story not unlike that of intracranial tumors. Although a cytological classification is on the whole the safest and would appear to be the ultimate solution for all tumors, the histological picture of neoplasms of the central nervous system is still susceptible of too many interpretations to be used exclusively as a differentiator. Particularly is this true in the differentiation of gliomata from sarcomata, and again in the separation of sarcomata from endotheliomata. Doctor Bloodgood [11] has shown how unreliable is even expert opinion on the purely histological interpretation of tumors of the breast. The histological diagnoses of tumors of the brain and spinal cord are equally as faulty.

TABLE I.

Meningeomata	Extradural neuromata	Other benign tumors	Inflammatory	Glioma and sarcoma	Carcinoma
10 cases Ages: 27, 40, 40, 41, 47, 47, 56, 58, 59, 62	4 cases Ages: 25, 38, 38, 50	(1) Osteoma from body of vertebra @51 (2) Embryonal fibrous tumor arising in body of vertebra, piercing dura @14 (3) Shell of bone between dura and leptomeninges @22 (4) Angioma @59 (5) Angioma @58 (6) Angiofibroma arising in thorax @19	(1) Gumma @37 (2) Tubercle (intramedullary) @30 (3) Post-inflammatory diffuse lesion @49 (4) Extradural tuberculoma @27 (5) Extradural mass of staphylococcus aureus origin @42	9 cases Ages: 11, 11, 12, 14, 15, 29, 29, 33, 45	2 cases. Ages: 46, 54.
Total 10	4	6	5	9	2

I have made no attempt to clarify these defects of classification. Rather, I have avoided attempts at finer differentiation. For example, gliomata and

sarcomata have been grouped together. A typical glioma is entirely different both in the gross and under the microscope from a typical sarcoma, but there are many intermediate pictures in which the personal equation largely determines into which class they belong. From a practical standpoint, they are essentially alike; neither is curable by extirpation.

Under meningeomas have been grouped tumors arising both from the dura and from the leptomeninges. There are seven of the former and three of the latter. There can be no question of the derivation of the dural tumors because of their firm outgrowth from the dura (Fig. 3). Many of these contain numerous psammoma bodies and they are often classified under psammomas (Fig. 5). Presumably those which have no such attachment and lie loosely imbedded in the pia-arachnoid, and seemingly do not arise from a spinal nerve, have their origin in the leptomeninges.

FIG. 3.—Drawing of dural endothelioma removed from the thoracic region. The striking depression in the cord is shown following its removal. The inset shows the dura attached and excised with tumor.

Although the character of many tumors is easy to determine, in others all the available information—from the operating table, the gross and microscopic examinations—should be utilized before attempting interpretation. A tumor easily recognized as a dural endothelioma may, by microscopical examination alone, be reported as a sarcoma. As a matter of fact, there are few tumors which the trained surgeon cannot recognize almost as well at the operating table as under the microscope—certainly the differentiation between a malignant and benign tumor can rarely be open to question when the tumor is exposed at the operation. I believe the differentiation of gliomata and sarcomata from the gross inspection at operation, both of the tumor's character and its point of origin, is on the whole safer. Before grouping gliomata and sarcomata together, I tabulated only two of the former and seven of the latter, basing the separation on the origin of the tumor within the cord (glioma) or without the cord (sarcoma). In two of the seven cases grouped as sarcomata, the point of origin was apparently in the lumbar enlargement. At least the tumors penetrated the cord but, except for this small part, the great mass of the tumor was free in the spinal canal, tightly packing but not invading the nerve roots of the cauda equina into the sacral canal. They are well recognized by neurologists and surgeons as a fairly well defined type of slowly growing tumors with insidiously developing symptoms. Adson [12] refers to them as ependymal gliomata. Their

point of origin would seem to indicate that this view is probably correct, though their gross appearance is more like sarcomata.

It will be evident that gliomata are far less frequent than the same type of tumors in the brain. This is probably due to the smaller volume, both relative and absolute, of the glia owing to the great concentration of the nerve paths in the spinal canal. Conversely, the meningeomata are relatively far more frequent in the cord than in the brain.

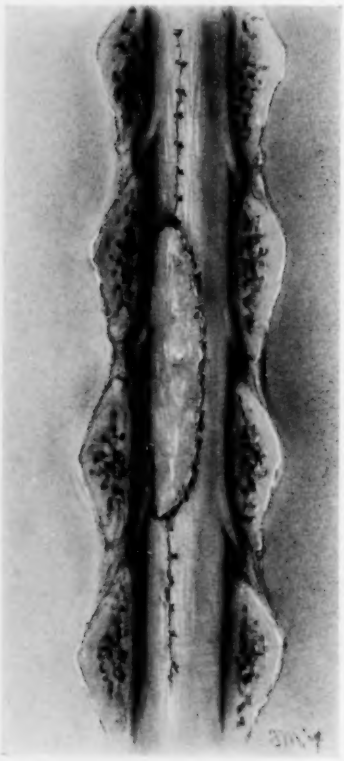

FIG. 4.—Showing area of dura resected with a dural tumor. An oval piece of fascia has been used to fill the dural defect.

Aside from these two great groups of tumors, one is impressed with the great number of totally different and unusual tumors affecting the spinal cord. There are no less than eighteen different varieties of tumors in this small series of thirty-six cases. The presence of only two cases of carcinoma in our series might appear to indicate that metastases to the spine were rare. Unfortunately, they are exceedingly common, but their clinical recognition makes operation unnecessary. They are therefore, not included among our certified tumors.

The extradural neuromata (4) are all very hard, perfectly encapsulated fibrous tumors. The fibrous tissue is irregularly arranged in layers, whorls, and pallisades. Into each a sensory and also a motor nerve were traced, but the structure of the nerves was soon lost in the tumor. Each tumor had a dumb-bell shape (Fig. 6), being constricted in the intervertebral foramen and expanding mesially but extradurally in the spinal canal and externally against the pleura (Fig. 7). It seems probable that the point of origin of these tumors is at the point of its constriction—*i.e.*, in the intervertebral canal and possibly from the ganglion. Two of our four cases were so full of giant cells as to suggest the histological diagnosis of giant-cell sarcoma.

Of unusual interest are the extrathecal inflammatory lesions, which behave like very rapidly growing tumors. One of these was tuberculous, the other apparently due to staphylococcus aureus. In each the attenuated organism had invaded the fat between the laminæ and the dura. Multiple minute foci were surrounded by a dense fibrous mass which, because of its increasing size, assumed the character of a tumor and compressed the cord (Fig. 10). The tuberculous mass followed a local trauma. Our presumptive diagnosis was a tuberculous abscess, despite the fact that there was no involvement of a vertebral body. The diagnosis of the staphylococcus mass was only suspected

when the level of the tumor was marked on the skin. It was found to bisect the scar resulting from the healing of a severe carbuncle. This coincidence at once suggested that the old carbuncle, which shortly preceded the symptoms, was responsible for a secondary inflammatory mass outside the spinal canal; the high cell count (45) supported this hypothesis.

One other exceptional type of tumor, or possibly pseudotumor, was a shell of bone surrounding the posterior half of the spinal cord and cauda equina for a length of at least nine vertebræ (Fig. 1). It lay between the dura and pia-arachnoid and, though snugly imbedded except in one short space where a nerve root tunnelled the bony formation, it was nowhere firmly attached. I have seen no reference to any such formation in the literature and have little to offer in its explanation. In a way, it suggests, on a grand scale, the pia-arachnoid plaques which one so frequently sees in explorations of the spinal cord. The two angiomata deserve special mention. Both were entirely venous and therefore without pulsation. The gross appearance was that of a mass of worm-like venous channels which entirely obscured the dorsal half of the cord from view. One was a single and sharply defined mass 8 cm. long, the other consisted of one large cluster and several smaller discrete patches joined together by a tortuous mid-dorsal vein. On removing these masses, one sees that one or more of the veins enter the substance of the cord. In explorations of the cord, less pronounced but very definite venous masses are not infrequently encountered; presumably they cause no harm, but their detection may misdirect the operator's search away from the real lesion. I have been guilty of one such mistake, the tumor (one vertebra higher than the angioma) being found and removed a year later. Curiously, his symptoms disappeared after removal of the angioma, and reappeared several months later, and the new sensory level was two segments higher than at the former admission.

The remaining tumors of interest will be briefly considered under "Operability of Tumors."

OPERABILITY OF SPINAL CORD TUMORS

The high percentage of operable intraspinal tumors is in striking contrast to that of the intracranial chamber with which it is natural to seek a comparison. The outstanding reason for this difference is the very favorable ratio of meningeomata to gliomata. Fourteen (40 per cent.) of this series of 36 tumors are encapsulated fibrous tumors: meningeomata (10) and extradural neuromata (4). All except one were totally extirpated, without mortality, and in none has there been any evidence of recurrence. The single exception was a leptomeningeal tumor on the ventral side of the first and second cervical vertebræ and just protruding into the intracranial chamber. It was an accidental finding at necropsy. The only difference of importance between tumors arising from the dura and tumors of the leptomeninges is that the former are harder, very firmly attached to the dura, and more difficult of removal. If their attachment is on the ventral or ventrolateral part of the

dura, the removal becomes even a greater undertaking because the spinal cord must be gently retracted to the side to give room for extirpation. If the dural tumor is situated laterally or dorsally, it is always preferable to excise the dural attachment also and transplant in its stead a piece of fascia. When attached on the ventral aspect, the dural venous sinuses prevent excision of the dura; the operator must then be content with scraping the dura, but even after such treatment there has been no instance of recurrence. It is often best to first remove the interior of the tumor and then the capsule. This plan of attack is principally applicable in the ventral or ventrolateral tumors, or when the tumor is relatively large. The intracapsular removal gives more room and allows the collapsed tumor to fall away from the spinal cord. The most important feature of any tumor extirpation is the avoidance of injury to the spinal cord. Resection of one or even two unimportant sensory roots, and at times even a thoracic motor root when the tumor is situated ventrally, allows the cord to be drawn away so that it can be covered with a layer of moist cotton which acts as an effective buffer to traumatic insults when working on the tumor.

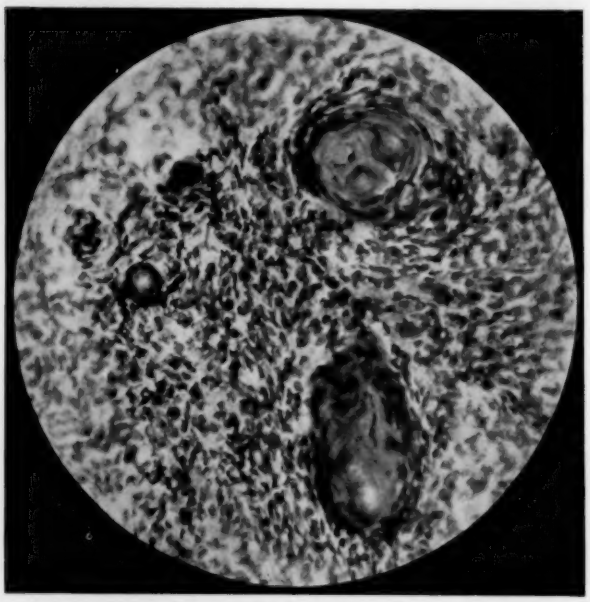

FIG. 5.—Microphotograph, high power, showing one small and two large psammomata. A high percentage of dural tumors show psammoma bodies.

The tumors arising from the pia-arachnoid are just as encapsulated (Fig. 2) but, the attachment being of a filmy nature, they can be easily elevated from their bed in toto. The neuromata are even more favorable for extirpation. Being entirely extradural the spinal cord is not exposed and is protected from operative injury by the intervening dura. It is necessary to remove the pedicles and transverse processes of the contiguous vertebræ in order to thoroughly expose the tumor and permit its safe extirpation. The transparent pleura and the moving lung beneath it afford a beautiful picture after the tumor has been removed.

Unless the paralysis has endured too long, perfect restoration of function will usually follow extirpation of all of these tumors. The single exception was a patient whose limbs were firmly fixed in contraction and in whom, aside from a bilateral Babinski, no reflexes could be elicited. Sensory, motor, and sphincter functions had been totally abolished for two and a half years.

When one sees the deep depression in the spinal cord produced by one of these tumors (Fig. 3)—usually the spinal cord seems reduced to about one-half its normal cross-section—one marvels at the perfect function that returns. The conclusion can be safely drawn that despite this gross depression in the cord, the fibre tracts are still intact for some time after complete paraplegia develops. Only the transmission of impulses is blocked. Doubtless much of the reduction in size of the cord is due to loss of water and of the vascular bed—a protective compensation similar to that which has been shown to exist, but to a much greater extent, in tumors and destructive lesions in the cranial chamber.[13] The rapidity of return of function after removal of the tumor is remarkable. If paralysis has not been longer than a few weeks, movements will frequently begin in thirty-six to forty-eight hours, and the patient will be able to walk out of the hospital in less than a month. The longer the paralysis has persisted, the slower will functions return, but even after paralysis of several months' duration, complete return of function will follow, though it will be much slower. The quick recovery of motor and sensory power after removal of spinal cord tumors is apparently quite analogous to the quick return of vision after extirpation of pituitary tumors—the functions in both instances being "physiologically blocked."

FIG. 6.—Photograph of extradural neuroma. Four of this series of tumors are of this variety.

In addition to the possible perfect results from this group of encapsulated tumors, there are eight other cases of diverse nature in which a perfect recovery resulted—six following extirpation of the tumor, one after antisyphilitic treatment, and one following radium. From the total of thirty-six tumors, therefore, there are 21, or 60 per cent., which could be totally extirpated or otherwise so treated that complete restoration of function will result. These statistics are identical with those of Adson.[14] In addition, there is a patient afflicted with a venous angioma who improved so rapidly after its removal that he walked out of the hospital, but who has since been lost to view. While there is reason to believe he is also cured, the proof of subsequent reports is lacking. The other six benign tumors which were completely extirpated with restoration of function are: (1) A tumor in a girl of fourteen, produced a characteristic Brown-Séquard syndrome. This tumor was surely of congenital origin, for it filled the body of the sixth cervical vertebra, leaving the bony cortex intact except at the point of perforation. Piercing the bony shell posteriorly, it perforated the spinal dura laterally and flared out into an intraspinal tumor which caused her symptoms (Fig. 11). The entire tumor, both within the spinal canal and the body of the vertebra, was shelled out

intact. She has remained perfectly well three years. Histologically, the tumor is like that of a dural meningeoma. (2) A sharply defined finger-like osteoma projecting from the body of the vertebra into the anterior surface of the cord; patient *æt.* fifty-one. (3) Six years ago a remarkable shell of bone lying over the dorsal half of the cord between the dura and the pia and extending from the ninth thoracic to the first lumbar vertebræ, inclusive, was removed from a girl *æt.* twenty-two. Five years later, and after complete recovery of function, motor weakness again developed and a bony shell of exactly the same type was removed from the second to the fifth lumbar vertebræ, inclusive (Fig. 1). Curiously, this slab of bone had five articulations, whereas the former specimen was solid, the difference doubtless being due to the effect of the fixed and movable vertebræ. (4) An extrathecal solid tubercle with well-defined limits was removed from a girl of twenty-seven, and (5) a very hard fibrous inflammatory mass containing many small subacute foci had formed extradurally in a man of forty-two, several weeks after a carbuncle had healed directly over the site of the present tumor.

In the last two cases the return of power has been slower. A study of the differences in time necessary for function to return suggests a rule that the rapidity of functional return is inversely proportional to the rapidity of functional loss from the tumor's growth. A rapidly growing tumor strangulates the cord and injures it, whereas a slowly growing tumor gives the cord a chance to gradually adapt itself to the intruder.

The only gumma in the series was in a woman *æt.* thirty-seven, who was on the service of Professor Thomas. There was complete block of the spinal canal. The symptoms and signs were those of a Brown-Séquard hemi-lesion. Until the Wassermann of the spinal fluid was found to be positive, the lesion was considered to be a tumor. Under antisyphilitic treatment, recovery was complete and she has remained well for three years. The last tumor to be included with those completely yielding to treatment, was in a girl of nineteen. Five (5) years ago she entered the hospital because of a rapidly developing paraplegia and loss of sphincter control. The X-ray disclosed a very large intrathoracic shadow. The intraspinal growth was a prolongation of this thoracic tumor which had evaded the vertebræ and reached the spinal cord. Doctor Finney explored the thoracic tumor, found it to have expansile pulsation and to be inoperable. A needle was inserted into it and blood spurted from the lumen. A presumptive diagnosis of angiosarcoma was made; a small piece of tissue was removed for microscopic diagnosis, but unfortunately was lost. Seemingly hopeless, she was given radium treatment by Doctor Burnham, and quickly her paralysis began to clear. In a few months she had completely recovered and has remained well to the present time (five years). It is interesting to note that despite the disappearance of the spinal cord disturbance, the radium had no effect upon the size of the röntgenographic thoracic shadow. The thoracic tumor has never given her symptoms. This brilliant result from radium treatment, however, has been exceptional. It is only fair to say that in nearly all the remaining inoperable cases radium has

been tried, but without any noticeable benefit, and in two recent cases deep X-ray has been of no greater help. Possibly the vascular character of this unusual tumor was responsible for the marked susceptibility to radium, whereas tissues of the nervous system are more refractile.

The incurable spinal cord tumors, sarcomata and gliomata (9), carcinoma (2), tubercle (1), comprise 33⅓ per cent. of all the tumors in the series. Unfortunately, with few exceptions, there is no certain way by which the *character* of the tumor can be foretold. Xanthochromia usually indicates a glioma or sarcoma, but this is not invariably true; an inflammatory lesion and a dural edothelioma gave this color change. Ofttimes the existence of a metastatic tumor can be known by finding a primary growth, frequently but not always, in the pelvis. Many operations would be avoided if gliomata and sarcomata could be differentiated from the curable tumors, but in the absence of such positive information, exploration of the tumor is always indicated. But the operation on many incurable tumors is well worth while, for the removal of the laminæ gives additional room, thereby acting as a decompression, effectively alleviating backache which is often excruciating; and at times a decompression may even permit a temporary return of some motor, sensory, or sphincter function by allowing tumors to "lift" from the spinal cord. The operative mortality in spinal cord tumors should be practically nil. There is one death in this series—from shock. This was one of the first of the series and followed removal of extensive multiple angiomata of the cord. This death would surely be avoided now. The completion of the operation in one stage, unless there are individual contra-indications, is practically always pos-

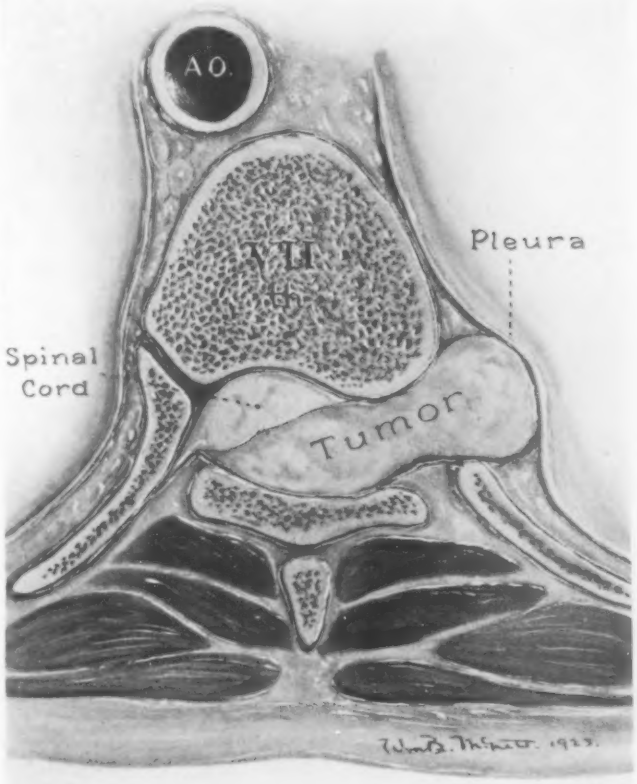

FIG. 7.—Diagrammatic drawing to show the situation and manner of growth of an extradural neuroma.

sible and preferable. In none of our cases have two stages been necessary. In children, often quite ill, it would be impossible to remove many of the extensive growths at one time, but these growths are mostly malignant or recurrent and attempted removal is not indicated; nor is it necessary to expose the entire extent of the tumor, unless to give a palliative decompression.

The operative technic needs little comment. The precise localization is all important. With this accomplished, the removal of laminæ from two, or at most, three vertebræ, is adequate. Even in the cervical region this produces no noticeable weakness. I have no experience with hemilaminectomy. It is far better to remove all the laminæ necessary than to hamper the exposure and removal of the tumor in the slightest degree. Ether anæsthesia has been used exclusively. Ether well administered has so few disadvantages in spinal cord surgery that, except in unusual conditions, the need of local or paravertebral anæsthesia, has never appeared—a marked contrast to many advantages of local anæsthesia in intracranial surgery. Far more important than any type of operation is the best possible exposure of the tumor, so that its removal is easy and free of danger to the cord. At times, despite scrupulous care in removing spinal cord tumors, urinary retention will develop. The treatment of this will be mentioned later.

THE CLINICAL FEATURES OF SPINAL CORD TUMORS

Probably the outstanding impression of our study of spinal cord tumors is the accuracy with which most spinal cord tumors can be diagnosed and localized, using only a careful history and neurological examination. It is exceptional when the information from these sources, backed by an experience which makes interpretations safe, is not adequate both for diagnosis and localization. Spinal cord tumors are so frequently overlooked because their frequency, both absolute and relative, is not appreciated. Given a gradually progressive bilateral loss of motor power with spasticity, the burden of proof is on any diagnosis other than a spinal cord tumor. This is the most likely lesion and almost the only one offering the patient relief. If there is a sensory level in addition to the motor loss, the location of the tumor is at once precisely made. Rectal, and particularly vesical sphincter disturbances, though usually appearing much later, complete the great triad of symptoms resulting from spinal cord tumors. Other symptoms, though important, are of lesser significance.

Sensory Level.—The most important of all objective determinations in spinal cord tumor suspects is the level of hypæsthesia or anæsthesia. Although usually easy to elicit, it may be very difficult, especially in tumors affecting the cauda equina. In thirty-five out of our thirty-six cases a sensory level was present, though in two of these it appeared only after a lumbar puncture. In the only case without a sensory level, the tumor was accidentally found at necropsy.

The importance of great care in the sensory examination is shown by the fact that in five of these thirty-five patients (14 per cent.) a sensory level was

missed by two of our examiners and picked up by the third. In each instance the sensory level was detected by testing for touch with a wisp of cotton. the finer changes in touch and pain denote a sensory level just as definitely as if there were a much greater hypæsthesia or even an anæsthesia.

Not infrequently there is a zone of one or two segments characterized by a lesser degree of hypæsthesia (occasionally there may be hyperæsthesia). This zone corresponds with the tumor's level and is doubtless due to its local effect. Although diminished sensation is usually bilateral and symmetrical at the time the patient comes to the physician for help, it may at times be unilateral.

Fig. 8.—Extradural sarcoma. No primary tumor could be found of which this tumor might be considered a secondary extension.

Two patients in this series presented the Brown-Séquard syndrome, so characteristic of lateral hemi-lesions of the cord. In each this unilateral hemianæsthesia, contralateral to the lesion, and upper segment motor paralysis with loss of muscle sense on the side of the lesion, were detected by Professor Thomas. Both were cervical tumors, one a fibroma, the other a gumma. While under observation the signs in each case changed from those of a strictly hemi-lesion of the cord to changes indicating partial involvement of the other half also. A careful history of many patients will give a story of a hemi-lesion and almost always of a partial hemi-lesion. Not only sensation but also motor disturbances appear on one side, days, weeks, months, or even years (in one patient two years) before the other side.

A careful history of the sequence of events will often tell in which part of the cross-section of the spinal canal the tumor is located. Initial sensory disturbances suggest a tumor on the posterior aspect of the cord. Motor symptoms preceding sensory loss, indicate a tumor situated more anteriorly; and a Brown-Séquard syndrome may be looked upon as evidence that the tumor is located laterally. The rapid progress of the signs and symptoms from one side of the body to the other, suggests that the tumor is either on the dorsal aspect of the cord or is intramedullary.

In a strikingly high percentage of these patients, regardless of the location of the tumor in the cord, the subjective sensory changes have begun in the toes, and gradually progressed up the foot, leg, and the abdominal walls to the permanent sensory level. Doubtless, this is due to the topographical distribution of the sensory fibres in the cord.

Only once have two operations been necessary to find a tumor after determining the sensory level. One year after a negative exploration, the

tumor was found one vertebra higher and in this interim the sensory level had shifted two segments upward. Possibly the sensory level on the first admission had been inaccurately made, though even a year later the diminished sensation was so slight as to have escaped detection until very delicate tests were used. At the first operation a well-defined angioma was removed from the dorsal surface of the cord at a level corresponding to the sensory findings at that time and, curiously, both sensory and motor symptoms almost entirely disappeared.

Motor Loss; Rigidity, and Flaccidity.—Other disturbances of function included in the clinical picture, though of more concern to the patient, are of secondary value in making a localization of the growth. The chief complaint of practically every patient is a gradual motor loss and associated with this are the manifestations of upper motor segment paralysis—spasticity below the lesion and involuntary muscular jerkings (convulsions). There are exceptions to this rule, however. In two of our cases there was *complete flaccid paralysis:* in one the lesion was an extradural tubercle and in the other an extradural sarcoma; in both the progress of the disease was very rapid, seven and ten days, and on admission to the hospital the loss of power, sensation, and sphincter control was complete. Such a clinical picture is analogous to that accompanying a complete traumatic transverse section of the spinal cord. A third patient also had flaccid paralysis, but this was a sarcoma involving the cauda equina; and as lesions of the cauda equina involve peripheral nerves, a flaccid paralysis is to be expected.

Involuntary jerkings of the affected extremities are a frequent source of annoyance before complete paraplegia ensues, and again when motor function is returning. Frequently they are described by patients as convulsions, which they doubtless are—though, of course, being of spinal origin they are without loss of consciousness. They probably occur, but in varying intensity, in most cases, though our records are not complete on this point. In only one case is there specific mention of their absence.

Pain.—Three kinds of pain result from spinal cord tumors: (1) localized pain from direct involvement of the sensory nerves by the tumor, (2) pains from pressure on the sensory tracts in the cord, (3) aching from intraspinous pressure.

Localized pain along the course of a sensory nerve—so-called root-pain—was present in at least twelve, or one-third of our cases. The pain was always severe, at times of a sharp lancinating character, much like the lightning pains of tabes, at other times a constant dull aching pain. But always the location of the pain has been unchanged and without exception it has been unilateral. Usually these pains antedate the onset of the spinal cord symptoms. In one instance the pain had existed ten years, another four, one "a number of years," and several for many weeks or months. That the pain has been due to the tumor during all these months and years, is a safe deduction, because it always refers back to the nerve involved in the tumor. It may be significant that nine were curable tumors, and the other three were

sarcomata. In the three latter cases the pain preceded the cord symptoms by only two months. It would appear that the duration of this localized pain might be a useful prognostic sign. In none of the intramedullary tumors (there were only three, however) was there pain of this character. It is not to be expected that intramedullary tumors should produce this type of pain, for they do not implicate the spinal nerves. The distribution of this pain in the series was: "kidney region," three cases; "lower ribs" (1); down arm (2); in axilla (1); shoulder blade (2); left groin (1). One patient was subjected to a nephrotomy operation for a presumed kidney stone because of sharp attacks of pain in this region. Whether one will eventually be justified in making a diagnosis of a spinal nerve or spinal cord tumor solely on the history of such a constant pain, is doubtful. As yet I know of no cases which have been operated from such a diagnosis.

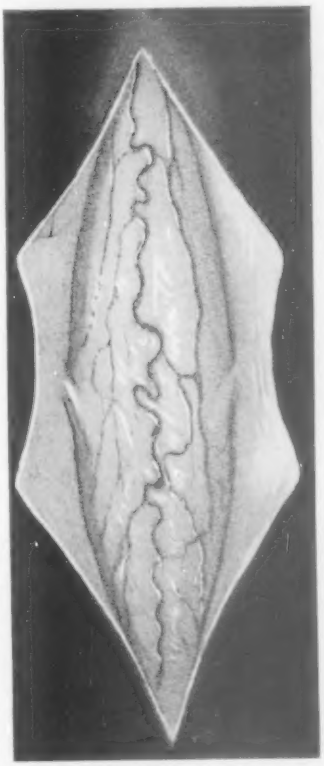

FIG. 9.—Drawing of a glioma situated entirely within the spinal cord.

Pain from pressure on tracts in the spinal cord at times also antedates both recognizable sensory and motor changes. In seven (7) of our thirty-six cases such pains have been recorded. It is interesting to note that both intramedullary tumors (gliomata) had severe pains down both legs. Usually sensory loss appears soon after the onset of these pains, but in one case a tumor at the third dorsal vertebra gave tingling pains down the right leg two years before the left leg and four years before there was any noticeable motor or sensory disturbance. It is worthy of note that the tumor was situated more to the left side of the cord, *i.e.*, contralateral to the subjective pain. Seemingly in keeping with the progress of the subjective sensory changes noted above, practically all of these pains have radiated down the legs, regardless of the location of the tumor along the spinal cord. In a tumor at the first cervical segment, there had long been sharp shooting pains down both legs. In two (2) cases the pain radiated "to the knees," in two (2) there was burning sensation down the left leg, and in another the tingling pain was for a long time restricted to the big toe of one foot. In the remaining cases there was no restriction of the pain other than "down both legs."

Girdle sensations were mentioned in ten cases, though doubtless they were present more frequently than the records indicate. This very common complaint is merely the patient's interpretation of the sudden change between the normal and the disturbed sensation, a transition which is usually so symmetrical as to make the suggestion of a band quite applicable.

The remaining type of pain is really a backache and is due to the excessive pressure within the inexpansile walls of the vertebral canal. It is exactly analogous to headache from increased intracranial pressure and, like it, is relieved by the removal of the laminæ—a spinal decompression. Backache of this character was present in fourteen cases. Its intensity varies, at times it is excruciating and is the outstanding complaint. It is always made worse by movement of the spine. The patients soon learn that the sitting position gives them the greatest comfort; at times they may be unable to lie down to sleep. The effect of posture on the alleviation of this pain is so characteristic that it is sometimes possible to make a snap diagnosis of spinal cord tumor when told that the patient can only obtain relief by the sitting posture.

FIG. 10.—Solid mass of inflammatory tissue situated extradurally and resulting from a carbuncle situated directly over the spine. This mass was extremely hard, almost cartilaginous, and contained numerous miliary abscesses.

Vesical and Rectal Disturbances.—Not the least dreaded sequelæ of spinal cord tumors—sphincter changes—were present in some degree in at least twenty-five of the thirty-six cases. That vesical control, previously unaffected, was lost in two cases immediately after lumbar puncture, is sufficient warning that this procedure is by no means harmless. Usually sphincter disturbances do not appear until both motor and sensory changes are quite advanced. The character of the urinary disturbance has varied. Typically, a hesitancy in urination preceded retention, and retention passes into incontinence, but this sequence is by no means constant. Not infrequently incontinence will be transient, control again restored, and later again be lost. At times incontinence may be the first expression of this disturbance. Although vesical and rectal loss of control are usually affected about the same time, bladder disturbances often appear first and exist for some time before the rectal sphincter is affected. In one case the patient was incontinent for urine eighteen months before rectal control was disturbed. In the two rapidly developing complete paraplegias, retention developed, though in one dribbling of urine first appeared and retention followed two days later. We are still unable to feel satisfied with any treatment of retention of urine, though it is our present belief that catheterization, with scrupulous cleanliness, carried out regularly every six or eight hours, probably carries less danger of cystitis and pyelitis than a retention catheter or by allowing the bladder to overflow.

Reflex Changes.—Typically, the deep reflexes below the segment affected by the tumor are exaggerated; the abdominal reflexes are absent, Babinski reflexes present, and ankle clonus positive on both sides. As tumors, however, vary in the transverse injury of the spinal cord, there are modifications of this

standard picture; often there is asymmetry in the reflexes on the two sides. For example, in the cord affections with a Brown-Séquard syndrome, the reflex changes appear only on the side of the tumor, the motor tracts on the opposite side being as yet unaffected. In complete or nearly transverse lesions, of which there are seven (7) in the series, no reflexes were obtainable or if present were very feeble. Tumors of the cauda equina affecting the distal neurone should not and do not produce increase, but rather a decrease in these reflexes. In the two cauda tumors of our series, the reflexes were abolished, the paraplegia in each being almost complete and flaccid.

Ankle clonus was noted in fifteen of our cases, but doubtless the actual number is higher. In only five cases of the series were the abdominal reflexes unaffected.

Blood Wassermann.—Examination of the blood for the Wassermann reaction was taken routinely in every case and with the single exception of the gumma was reported negative.

X-ray Examinations.—Routine X-ray examination of the spine in the suspected zone was helpful in only two cases. In one there was a dense shadow of a great primary intrathoracic tumor, and in the other there was destruction of the transverse processes of the sixth and seventh cervical vertebræ, and in addition a calcification of the cervical extension of the tumor. In one case where the body of the vertebra was filled with a fibrous tumor, and in another where the laminæ were markedly eroded, subsequent examination of the X-ray plates still failed to disclose these defects. There are probably few tumors of the body lying adjacent to bone in which the X-ray is less helpful. This is not a reflection on the X-ray, but rather upon the rarity of bony changes, and also upon the background which makes difficult the detection of even considerable destruction of bone which may occasionally develop. Even very gross changes could hardly be evident except with stereoscopic vision. The well-known destructive changes in the vertebræ due to a carcinoma are excluded from this generalization. Except in rare instances, spinal cord tumors do not reach the interior of bodies of the vertebræ.

Age of Patients Afflicted with Tumors of the Spinal Cord.—The accompanying table shows the frequency of benign and malignant tumors according to decades.

TABLE II.

Table Showing the Incidence of Tumors According to Decades

Age:	1–10	11–20	21–30	31–40	41–50	51–60	61–70	Total
Benign	..	1	5	3	7	5	1	22
Malignant	1	5	2	2	3	1	..	14
Total	1	6	7	5	10	6	1	36

A few conclusions are warranted: (1) encapsulated, curable tumors are uncommon under the age of twenty, and the overwhelming proportion are

malignant, (2) that benign encapsulated, curable tumors appear in a fairly even proportion between the ages of twenty and sixty, and (3) incurable tumors, though less frequent than benign, are also fairly evenly distributed during the same period; (4) from this series of cases 70 per cent. of all tumors appearing after the second decade were removable and permanently curable.

Duration of Symptoms.—The accompanying table indicates that from the duration of the patient's symptoms little inference can be drawn as to the curability or incurability, encapsulation or non-encapsulation of the tumor. It has always been our impression that very rapidly growing tumors are more probably malignant, and those of long duration are more suggestive of benign growths. While this impression still holds to some extent, there are too many exceptions to look upon it as more than a very rough indicator.

TABLE III.

Table Showing the Duration of Symptoms Before Admission for Operation

Age:	3 Months	4-6 Months	7-12 Months	1-2 Years	2-3 Years	3-4 Years	4-5 Years	5+ Years	Total
Curable	..	2	3	5	3	1	4	4	22
Incurable	3	3	..	3	2	2	1	1	15
Total	3	5	3	8	5	3	5	5	37

LUMBAR PUNCTURE AND SPINAL FLUID EXAMINATIONS

Twenty-four (24) of the thirty-six cases (66 per cent.) had lumbar puncture and spinal fluid examinations. This is a much higher percentage than is now necessary. While there are no great contra-indications to spinal puncture, we have avoided subjecting patients to unnecessary examinations which are more or less painful, and which carry certain potentialities of harm, even though they may be transient. Surely, if there is the least doubt as to the nature of the lesion, spinal punctures are necessary. I have previously noted that in three instances a sensory level suddenly appeared after a lumbar puncture. This information in two instances, however, was obtained at the cost of a sudden startling paraplegia and urinary retention. Elsberg and Stookey [15] report an increase in the patients' symptoms in ten cases from their series. Although the removal of the tumors shortly afterwards always gives complete return of all functions, these sequelæ of the puncture were naturally very alarming to the patients and made us wonder if a more careful sensory examination might not have detected the sensory level and made lumbar puncture unnecessary. The cause of the occasional sudden increase in spinal cord injury following lumbar puncture is not entirely clear, but it would seem that the sudden release of cerebrospinal fluid probably forces the tumor downward owing to the unrelieved and unopposed pressure above the tumor. It will be recalled that tumors produce deep depressions in the spinal cord, and dislocation of the tumor downward probably allows it to injure the part of the

spinal cord which projects under the tumor. If such an explanation is correct, it would seem impossible that similar cord injuries could occur after cisternal puncture.

From examination of the spinal fluid in twenty-four cases, the following information was obtained: Xanthochromia was present in eight as follows: a long-standing dural meningeoma (slightly yellow), an extradural inflam-

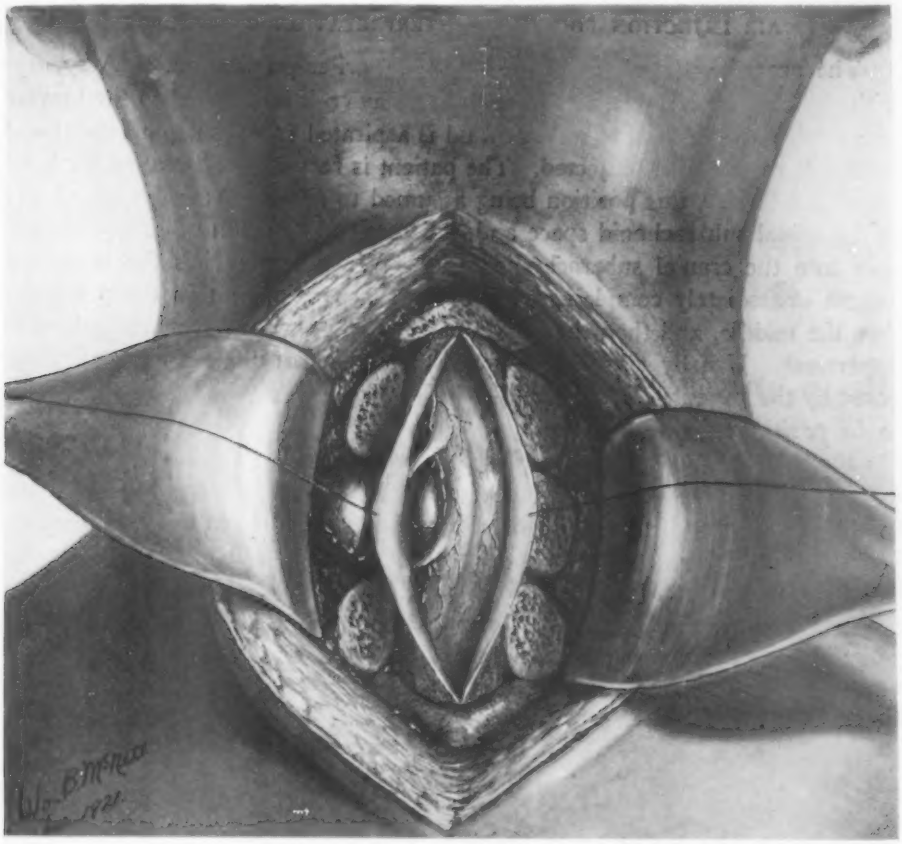

FIG. 11.—Fibrous tumor in the cervical spinal canal. This tumor extended through a small perforation in the dura and in the cervical region grew into the body of a vertebra, reducing it almost to a shell. The entire tumor was encapsulated and removed in toto. After three years there has been no recurrence.

matory mass, a tuberculous extradural mass, a gumma, three sarcomata, one extradural and two intradural, and one glioma. Globulin was recorded sixteen times; occasionally there was a slight increase, but usually a heavy (4+) cloud was present.

The cell count was recorded sixteen times as follows: one cell (4), two cells (2), three cells (2), four cells (3), nine cells (dural meningeoma), fourteen cells (extradural sarcoma), fifteen cells (extradural tuberculoma), forty-five cells (verified) (chronic staphylococcus extradural mass), and sixty-one cells (not verified) (extradural sarcoma).

An increase in globulin, while not invariably present, is the usual finding

and is present in all types of tumors. Xanthochromia was found only once in the intra- and extra-dural encapsulated fibromata and was present in three of the four inflammatory lesions and in many of the sarcomata and in the only glioma case from which fluid was obtained. Important as is this information, it can hardly be claimed that it is necessary either for diagnosis or localization after a careful neurological examination has been made.

AIR INJECTION ROUTINE. INTERPRETATION OF RESULTS

The procedure has been described in an earlier publication.[16] A syringe with a rubber connection containing a two-way cock is attached to the lumbar puncture needle. Ten (10) c.c. of fluid is aspirated from the spinal canal and an equal amount of air injected. The patient is recumbent, but at an angle of about 50° to 60°, this position being assumed to allow the air to rise quickly in the spinal subarachnoid space and, unless an obstruction exists, to pass at once into the cranial subarachnoid space. When air reaches the head, the patient immediately complains of a fairly sharp pain, first in the posterior, then the middle, and then the anterior part of the side of the head which is uppermost. Usually these successive localizations of the air's progress are noted by the patient. *So constant and characteristic is this pain that it seems to be positive evidence that there is no complete block of the spinal canal. On the other hand, if the patient does not complain of pain in the head after a spinal injection, there must be a spinal block.* The röntgenographic evidence of the presence or absence of air in the cranial chamber in a series of cases has already substantiated the above subjective results. The presence of air in the cerebral ventricles or sulci denotes the absence of a total spinal block; the absence of air indicates a total block.

Variable amounts of air are injected, depending upon the individual case. If air reaches the head at once, 10 c.c. will give as much information as any greater amount. If air does not pass into the cranial chamber, it is better to inject as much air as the spinal canal will hold in order to get the maximum effect of the air shadow for röntgenographic localization of the tumor. Below a tumor which occludes the spinal canal, air does not cause pain, ache, or any injurious effect, either immediately or subsequently. The absorption of the air from the spinal canal is sufficiently rapid to prevent any trouble. We have tried various positions of the spine with reference to the X-ray plate in order best to define the air shadow. We now take only a single stereoscopic plate, the patient lying on the back and the rays passing straight through. This position gives the constant dense background of the vertebral bodies, against which the artificial air shadow is best thrown in relief. In lateral or partial lateral views, the loss of this constant background makes difficult the evaluation of the spinal air shadow against the variable air and visceral shadows of the thorax and abdomen. Curiously, air in the spinal subarachnoid space produces practically no pain comparable with that in the cerebral subarachnoid space. However, nerve root pains resulting from the irritation of the air will radiate along the course of the nerves which are fixed by the tumor.

Though usually unilateral, these pains may at times be bilateral. When a tumor is present these pains have always marked its location. However, I have occasionally observed similar pains, of more fleeting character and of less constancy, when no spinal block was present. Pains of this kind are, therefore, of importance as corroborative but not absolute evidence of a tumor's location.

An additional determination of interest and of some value is the quantity of air which can be aspirated when the spinal canal is blocked. In several instances, 30 c.c. have been obtained when tumors were located in the mid and lower thoracic regions where most of our tumors have been. When that part of the spinal canal below the tumor has been drained of cerebrospinal fluid, as evidenced by the reaspiration of air, the volume of this part of the spinal canal can be estimated with fair accuracy. The value of this determination is that it roughly marks the region where the air level may be sought with the X-ray.

RESULTS OF AIR INJECTIONS

CASE I.—Mrs. D. H., *æt.* forty-nine. Two negative explorations had been performed (1½ and 2 years ago) at another hospital for a presumed spinal cord tumor. The symptoms were of 4½ years' standing. There is now complete paralysis of all muscles of lower extremities with strong contractures. Sensation ended sharply at the 10th thoracic segment. Loss of rectal and vesical control is complete. The spinal fluid was slightly yellow (Xanthochromia), 9 cells and 4+ globulin.

Queckenstedt's Test.—Indicates no obstruction; fluid beginning at 15 centimetres quickly rose to 40 with jugular compression and fell with release of the compression.

Air Injection.—Thirty c.c. of fluid was aspirated and an equal amount of air was injected. More fluid could not be obtained. *Immediately after the air was injected, pain radiated to the kidney region on the right side.* For years this had been the site of her spontaneous pain. Headache did not follow. Skiagram of the head showed no air in the cerebral sulci. *The air column was plainly defined at the eighth thoracic vertebra.*

A dural endothelioma was completely removed, but due to the long duration of her paralysis no function had returned one year later.

Comment.—The history alone should easily have been adequate both for the diagnosis and localization of this tumor, the negative operations notwithstanding. It is interesting that after such a long period of growth (4½ years) Queckenstedt's test should still fail to show a block in the spinal canal; also, that air disclosed a complete block when Queckenstedt's test indicated a patent canal. Another point of importance is that the original pain was duplicated by the air test. The fact that only 30 c.c. of fluid could be obtained (after which the air was reaspirated) was additional proof of an obstruction in the spinal canal and roughly indicated its location.

CASE II.—Mrs. E. S., *æt.* forty-five. Pain and rigidity of back for four years, pain intensified by movement. Paralysis has been gradually increasing for over a year. There is a faint but definite sensory level at the twelfth thoracic segment on both sides. The ankle jerks are absent; Babinski negative. The spinal fluid is yellow, contains four cells, globulin 4+.

Queckenstedt's test indicates no obstruction.

Air Injection.—Thirty-five c.c. of fluid was aspirated and the same amount of air injected. There were no referred pains or sensations and no headache following the injection. More fluid was not obtainable, only air being reaspirated with further trials. As an experiment, an additional amount of air was injected under pressure. The resistance

to the injection was very distinct. At first nothing was noted, but there soon appeared pain in the head, and air-filled cerebral sulci were then demonstrable in the skiagram. Additional aspirations again brought only air into the syringe, showing that the obstruction of the spinal canal was still essentially complete. After all of these tests the skiagram showed a sharp tumor level at the eleventh (11) thoracic spine.

A very extensive glioma (entirely within the spinal cord), was found at operation. Extirpation was not attempted (Fig. 9).

Comment.—Again the history and neurological examination should have been sufficient both for diagnosis and localization. Queckenstedt's test failed to show an obstruction, which the air test both indicated and accurately defined. It is of interest that with an increase of pressure, air could be forced past the obstruction. The amount of fluid which could be obtained from the spinal canal was about the same as in the preceding case.

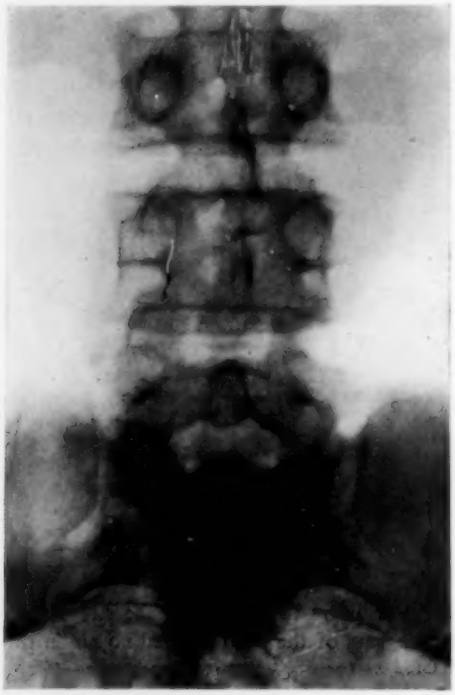

FIG. 12.—Lipiodol has dropped to the bottom of the spinal canal a few minutes after its injection into the cisterna magna. From this quick and complete passage of the oil, one is justified in excluding the diagnosis of a spinal cord tumor.

CASE III.—W. W. is a co'ored boy, *æt.* six, with gradually increasing paralysis of the lower limbs (more left). Backache has been very severe. There is a bilateral very faint sensory level at the first lumbar segment. The first and second lumbar spines are tender to deep pressure. Babinski is negative on both sides; left K. K. not obtainable; right normal. The spinal fluid is distinctly yellow; globulin 4+.

Queckenstedt's Test.—The spinal fluid rose from 180 to 300 on jugular compression and instantly fell to the original level on release of pressure, indicating that there is no obstruction in the sp'nal canal.

Air Injection.—At the same lumbar tap, 40 c.c. of air was injected. More fluid could not be obtained. Headache did not follow the injection, nor were air-filled sulci present in the skiagrams of the head. The lower surface of the tumor was sharply defined as a conical shadow at the level of the first lumbar vertebra (Fig. 16, arrow A). Moreover, along each of the spinal nerves below the level of the tumor was an oval air shadow about a centimetre long (Fig. 16, arrow B). These pouches were dilatations of the subarachnoid space at the point of emergence of the spinal nerves, and were due to the high pressure of the fluid caused by hydrocephalus of the communicating type. This finding has been unique. In addition to the spinal cord tumor, this patient had a growth in the region of the pituitary body and another along the brain-stem. The latter caused hydrocephalus by obstructing the cisterna pontis. The pressure of the spinal fluid distended the arachnoid sheath of each of the nerves—as shown by the air shadows. On careful inspection of the röntgenogram, a narrow column of air can be seen on the right side of the tumor, and extending laterally from it is a patent subarachnoid pouch along one spinal nerve. The obstruction to the air was complete, although fluid apparently passed freely around the tumor, doubtless where the column of air partially encircled one side of the tumor.

It is worthy of note that three (3) days after the above tests, a Queckenstedt test

was again made. The initial pressure was 300 mm. water. On jugular compression, the pressure rose to 340 but did not fall with release of this pressure—*i.e.*, the spinal canal had now begun to show evidence of an obstruction to fluid.

Operation.—A small fibromyxoma was removed from the lumbar enlargement and the beginning of the cauda equina.

CASE IV.—William B., *æt.* fifty. A progressive loss of power and sensation had been gradually developing for four months. There was a sensory level at the ninth thoracic segment. Urinary incontinence had just appeared. The abdominal reflexes were absent; no ankle clonus. The spinal fluid was entirely negative. Dorsal flexion of the big toe on both sides.

Queckenstedt's Test.—The spinal fluid rose from 90 mm. to 135 on jugular compression, but fell very slowly, eventually reaching the same level. The slow fall of the fluid level may be regarded as suggestive of a block, though on repeated jugular compression the same quick rise of fluid occurred.

Air injection into spinal canal: Thirty c.c. of air replaced an equal amount of spinal fluid; no pain in head; no air-filled cerebral sulci in the röntgenogram of the head. A röntgenographic shadow of the air is well defined at the level of the ninth thoracic vertebra.

Operation.—External dumb-bell shaped neurofibroma arising from the eighth thoracic nerve in the region of the ganglion (Figs. 6 and 7). The tumor projected through the intervertebral foramen and again enlarging pushed against the pleura. Total extirpation of the tumor was followed by rapid and complete restoration of motor, sensory, and vesical function.

Comment.—The story of a gradually progressive paraplegia with a sharp sensory level should have made additional evidence unnecessary. The air injection was made in this instance only to satisfy one who was unconvinced. Again, Queckenstedt's test failed to prove a block, which the air injection both proved and located.

CASE V.—Agnes E., *æt.* twenty-seven. Patient complained of a constant severe pain in the back and along the margins of the ribs. The pain dated from a blow on the back eight weeks ago. Paralysis and anæsthesia of both legs rapidly began one week ago and was now complete. The fourth thoracic spine was very tender to pressure. The paralyzed limbs were *flaccid*. All reflexes were absent below the sensory level (sixth thoracic segment). Spinal fluid: slight Xanthochromia, fifteen cells, globulin 4+.

Queckenstedt's Test.—From a primary level of 115 mm. the cerebrospinal fluid rose to 145 mm. on jugular compression but failed to return when the pressure was withdrawn. There was no oscillation of the fluid with respiration.

Air Injection.—Twenty-five c.c. of air was injected after withdrawing an equal amount of fluid. That the air did not reach the head was shown by the absence of headache and the absence of the air-filled cerebral sulci in the röntgenogram. A fairly sharp line of the upper limit of the column of air was located at the fourth dorsal segment. *Following the air injection, the original nerve root pains were greatly intensified.*

Operation.—A large solid extrathecal tuberculoma was removed from the dorsal surface of the dura at the level of the third and fourth thoracic vertebræ. It was tightly wedged between the laminæ and dura causing compression of the spinal cord. The extradural fat was incorporated in the inflammatory mass. Restoration of all functions followed operation, though much more slowly than in the preceding case.

Comment.—Although a sharp sensory level was present, a myelitis had to be considered because of the rapid paralysis. The air test was, therefore, necessary only in diagnosis; the sensory level was adequate for localization.

CASE VI.—Lena D., *æt.* twenty-three. (Reported by kindness of Professor H. M.

Thomas.) Her chief complaints were: severe and persistent pain in the cervical spine and down arm; weakness of the left arm and leg; numbness of the right arm and leg. A typical Brown-Séquard syndrome was present with characteristic reflex changes. The Wassermann from the blood was positive. Spinal fluid: straw-color; four cells; globulin 4+; *positive Wassermann.* Under antisyphilitic treatment signs and symptoms disappeared.

Queckenstedt's Test.—The cerebrospinal fluid rose from a level of 195 mm. to only 210 mm. on compression of the jugular veins, and did not return when the jugular pressure was released. These results indicate a total occlusion of the spinal canal.

Air Injection.—No air reached the cranial chamber. The air level was only fairly clear at the 5th cervical vertebra; tracheal air shadows always make superimposed artificial air shadows difficult of interpretation. Pain in both arms (the original pain) instantly followed injection of the air.

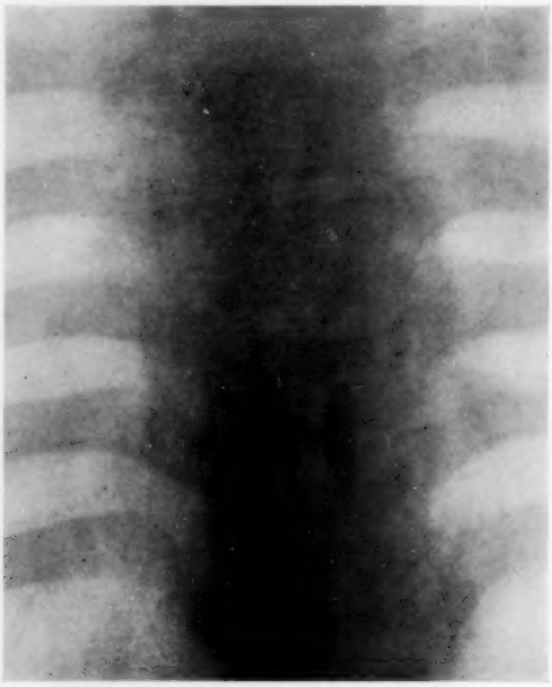

FIG. 13.—The lipiodol has stopped at an obstruction in the spinal canal, caused by an old fracture. The shape of the lipiodol mass is determined by the adhesions which have formed.

Treatment and Comment.—A presumptive diagnosis of a spinal cord tumor was made. The positive Wassermann in both blood and spinal fluid, caused the diagnosis to be shifted from a tumor to a gumma. Following antisyphilitic treatment by Doctor Thomas, she recovered completely.

Several months later she consented to a second air injection. The air at once passed into the cranial chamber and caused headache. In the röntgenogram air could be seen both in the cerebral sulci and the lateral ventricles. *With the cure of her symptoms there was therefore proof that the obstruction in the spinal canal had disappeared.*

CASE VII.—H. T., *æt.* fourteen. Because of a most intense backache and pain, patient's only position of comfort was sitting upright. Her symptoms, which were of only three weeks' duration, had progressed so rapidly that she was now completely paralyzed and anæsthetic below the eighth thoracic segment. There was marked tenderness on deep pressure of the sixth thoracic spine. The paralysis was flaccid and all reflexes below the sensory level were abolished except that there was a positive Babinski on both sides. Spinal fluid: four cells, positive globulin, no Xanthochromia.

Queckenstedt's Test.—The pressure of the cerebrospinal fluid registered 180 mm. and did not rise when the jugular veins were compressed. This indicated a complete obstruction.

Air Injection.—Only 20 c.c. of fluid could be aspirated; pain along both eighth dorsal nerves followed the injection. Air did not reach the head. The lower margin of the tumor was sharply defined by the air shadow in the röntgenogram (Fig. 15).

Comment.—Queckenstedt's test was quite positive. The air test showed a complete

block and accurately localized it, though it could hardly be claimed that either test was essential either for the diagnosis or localization.

DIAGNOSIS AND LOCALIZATION OF TUMORS WHEN THE LUMBAR CANAL IS CLOSED

CASE VIII.—W. W., *æt.* forty-nine. During the past seven years patient has had three attacks of very severe lumbar pain radiating down the legs. The attacks were two years apart, came without warning, persisted about three months, holding him bedfast, and then passed off without any after effects. After the last attack (2 years ago) difficulty in walking began, steadily increased, and for six months he had been confined to bed. There was now bilateral spastic paralysis with little voluntary power and some loss of sensation beginning at the eighth thoracic segment. The sensory level was detected only by using wisps of cotton and finer shades of heat and cold; K. K. and Achilles reflexes hyperactive; bilateral Babinski; no ankle clonus.

Spinal Fluid.—Less than 0.5 c.c. of clear fluid could be obtained; 2 cells; globulin +.

Queckenstedt's Test.—Manometric reading not possible because only drops of fluid obtainable; jugular compression did not increase the flow.

Air Injection.—No fluid could be aspirated; nor was it possible to force more than a cubic centimetre of air into the spinal canal because there was no free space. Air pressure applied to the spinal canal caused sharp pains to radiate down both legs.

Comment.—It seemed clear that some lesion had practically obliterated the spinal canal at the site of puncture (3rd lumbar vertebra). But the sensory level was at the sixth thoracic vertebra (8th segment). If both observations were correct, the lesion would extend over a length of at least nine vertebræ—hardly a probability if the lesion were a tumor. A diffuse chronic inflammatory process was disclosed from the sixth to the ninth thoracic vertebræ and, though not followed further, it surely extended into the lumbar canal. The cord was to a large extent destroyed and replaced by numerous cystic spaces lined by dense fibrous tissue. They were isolated from each other and apparently also from the subarachnoid space above. The fluid obtained from lumbar puncture was doubtless from one of these pockets. We were greatly puzzled at the time by the seemingly paradoxical findings. The chief practical inference which might have been drawn was that it was a lesion so extensive as to have permitted no benefit by operation. This would have spared a useless laminectomy. Recently another case has been under observation with almost precisely similar findings, and he was advised that operation was contra-indicated.

The pain referred down the legs when the air was forced under pressure (several times repeated), is almost surely explained by stimulation of the nerve roots which were in contact with the local cystic pocket. The other case just referred to gave excruciating pain down only one leg, but each slight pressure gave identically the same pain. Even had there been no sensory level, the evidence from the lumbar puncture and air test alone should have localized the lesion to the lumbar spinal canal.

CASE IX.—A boy of eighteen had suffered from dull aching pain for over four years and until recently had shown nothing objective except that he was less adept at play than other boys. There had been some scoliosis and he held the lumbar spine more or less rigidly. Two months ago while at camp his right leg began to drag. He was a precocious youngster and a diagnosis of hysteria had been repeatedly made by the most competent medical advisors. It was only after the left leg also became affected that I saw him. His lumbar spine was very rigid and tender on deep pressure. Although sensation at first seemed unimpaired, very careful tests showed a faint but definite hypæsthesia at the twelfth thoracic segment (9th thoracic vertebra). The following is a recapitulation of the essential reflexes: K. K. and Achilles slightly hyperactive; Babinski negative; no ankle clonus; Kernig positive both sides.

Spinal Fluid.—None could be obtained on three successive attempts.

Queckenstedt's Test.—On one occasion blood-tinged fluid rose to 140 mm., and on jugular compression climbed to 160 but did not return on release of the venous obstruction.

Air Injection.—It was impossible to inject air for there was no space. A severe backache resulted when increased pressure was applied.

Comment.—Our interpretation, which proved to be correct, was that a tumor filled the lumbar canal at the site of puncture and that the arterial blood-tinged fluid was additional evidence of this. Although the tumor (an extensive glioma or sarcoma) could not be removed, immediate relief of the backache resulted from the decompressive laminectomy. Some motor function also returned following this simple relief of pressure

FIG. 14.—X-ray photograph showing the shadow of tracheal air which makes the localization of air shadows of tumors in the cervical region difficult of interpretation.

CASE X.—Five years ago I removal a hemi-cylindrical shell of bone lying between the dura and the pia-arachnoid and extending from the eighth to the twelfth thoracic vertebræ. Complete relief of all signs and symptoms followed. Loss of motor function with spasticity was again developing slowly and made us fear a recurrence. But there was no evident sensory impairment. There was a suggestive ankle clonus on the right, a bilateral Babinski, slightly increased reflexes, and a positive Romberg. Spinal fluid could not be obtained. Queckenstedt's test could, therefore, not be applied.

Air Injection.—No air could be pushed into the spinal canal.

Comment.—That the needle had entered the spinal canal was certain, for pain radiating down the legs was evidence that the needle caught the nerves of the cauda equina. It was our belief that the lumbar canal was completely filled, probably by tumor similar to the one previously removed higher up in the spinal canal. The lumbar region was exposed at operation and a hemi-cylindrical bony shell extending from the twelfth thoracic to the first sacral vertebræ was removed. The tumor, if such it may be termed, was similar to the one previously removed from the thoracic region and of which there was no sign of recurrence. The bony mass completely filled the spinal canal and prevented the escape of fluid from the lumbar puncture.

Summary.—The three tumors in the lumbar spinal canal in this series have shown only faint sensory changes in two instances and none in the third. In one case no fluid and in two only a few drops flowed from the needle, because the tumors had completely or almost completely filled the lumbar canal. But in none could fluid be aspirated and in none could air be injected. The absence of fluid and the inability to push air into the spinal canal, I believe to be important evidence of a tumor or some other type of space-obliterating lesion

in this region. It is, however, recognized that localizations upon such evidence are open to the objection that the spinal puncture might be faulty. At the time of these operations, Sicard's method had not yet appeared. Had we felt any doubt as to the position of the lesion, we would have injected air into the cisterna magna and elevated the hips to allow the air to pass caudally. Since the advent of Sicard's method, any hesitancy in diagnosis or localization could better be cleared by his oil.

I have had no tumors situated caudal to the site of the lumbar puncture. It is clear that neither the diagnosis nor the localization of these tumors could be accomplished by any information from lumbar puncture or Queckenstedt's test. While it is probable that air injections might be useful for this purpose, if the injection were made into the cisterna magna and the pelvis elevated, I should now much prefer Sicard's procedure.

THE USE OF SICARD'S "LIPIODOL" IN THE DIAGNOSIS AND LOCALIZATION OF SPINAL CORD TUMORS

As previously noted, Sicard's oil contains iodine which casts a striking opaque shadow in the X-ray; the iodine is so well protected by the oil that no noticeable irritation of the cord follows its introduction into the spinal canal. When half a cubic centimetre (or less) of this oil is injected into the spinal canal, the oil normally descends to the most dependent part of the spinal canal. The injection can be made either into the lumbar canal or, much better, into the cisterna magna (Ayer's puncture). The disadvantage of a lumbar injection is that the head must be dependent, sometimes for many minutes, making a most uncomfortable position, and the best incline obtainable is far short of the vertical position. When introduced by the cisternal route—a simpler and less painful procedure than lumbar puncture—the sitting posture offers the maximum opportunity for gravitation of the oil. Another disadvantage of the lumbar injection is that the nerve roots at the lumbar enlargement sometimes catch and hold the oil, thus suggesting an obstruction when none really exists. I have seen two negative explorations of this region, both made for obstructions indicated by lipiodol, whereas had the oil been injected into the cisterna this mistake could hardly have occurred. While the oil gravitates quite readily, it is tenacious and can easily be retained if it does not get a good start or if the position is not sufficiently upright. We have also been warned by Sicard that the inclusion of air with the oil may retain the oil at the point of injection.

Since all of our cases were studied before Sicard's discovery, I am unable to include any results in tumor localization from lipiodol. However, I have used it in ten cases in which spinal block followed fracture of the spine (Fig. 13) and in cases where the diagnosis of spinal cord tumor was considered and excluded by the method. In one instance an obstruction was located at the lumbar enlargement by a lumbar injection of lipiodol, and a second at the cervical enlargement by a cisternal injection. Since multiple lesions were surely present, operation was not advised. Several times under the fluoro-

scope we have observed gravitation of the opaque shadow. If the patient is sitting and the injection is made into the cisterna—surely the method of choice—the oil drops very quickly to the bottom of the dural sac. With the full play of gravity there seems to be little possibility that the progress of the oil will be impeded except by a real obstruction. I have seen no harm result from the oil. Aside from a temperature reaction lasting over two weeks in one patient, I have seen no ill effect. There has been no pain either at the time of injection or subsequently.

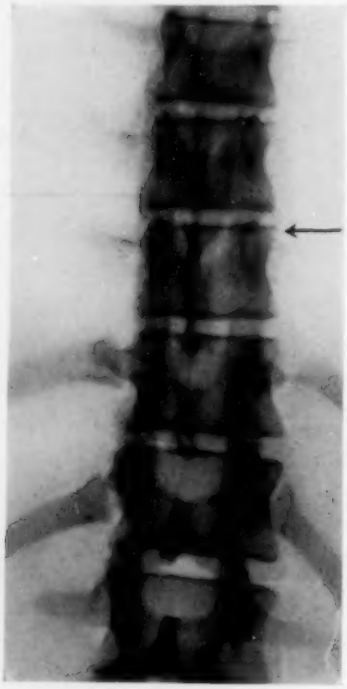

FIG. 15.—Photograph of X-ray of spine (not retouched) to show localization of the lower margin of a spinal cord tumor by the air shadow. Air can be seen distinctly as a column through all the vertebræ below the arrow. The shadow as here reproduced is necessarily much less sharp than in the original. The tumor was an extradural sarcoma. (Case VII.)

SUMMARY AND CONCLUSIONS

There is but one treatment for spinal cord tumors—removal by operation. Sixty per cent. of all spinal cord tumors can be totally removed and without chance of recurrence. The operation should be attended by no mortality.

A careful history and a painstaking neurological examination are adequate to make both a correct diagnosis and a precise localization in probably over 90 per cent. of all spinal cord tumors. In the remaining 10 per cent. the accessory methods—air or lipiodal injections—will make the diagnosis and localization accurately. As the precision of neurological examination diminishes, the need for air or lipiodal injections increases proportionately. Fortunately, these tests do not add any appreciable danger and very little discomfort. When there is the slightest doubt of the presence of a lesion or of its character, their advantages should be utilized. Operative procedures (laminectomies) are no longer warranted until the localization of a lesion has been positively determined.

Examination of the spinal fluid gives information which, though important, is rarely essential. The not infrequent loss of sphincter, motor, and sensory function following lumbar puncture, makes this simple procedure objectionable—even contra-indicated unless one is prepared to immediately follow up any adverse effect by extirpation of the tumor. Though the originator of the air injection method, I have always had an aversion to the use of any accessory examinations unless, of course, they gave necessary information. The dependence on mechanical methods should always be deprecated if by their employment one makes neurological examinations with less painstaking care.

Queckenstedt's test is too unreliable to be considered at all trustworthy.

In only two cases was a complete closure of the spinal canal positively shown by the failure of the spinal pressure to rise and fall following compression of the jugular veins. In three cases the results were equivocal, there being a less pronounced rise and at other times a delayed fall after an apparently normal rise. In four other cases there was no evidence of a spinal block, when the air test demonstrated a complete block. At best, the procedure is limited to diagnosis and is of no help in localization.

As between air and lipiodol injections, something is to be said for and against each method. There are really but two objections to the use of Sicard's lipiodol—(1) it remains indefinitely in the spinal canal and (2) at times may lodge where there is no tumor. The latter objection is hardly tenable, however, for when the oil is properly used the true level of the obstruction should be indicated. Should the prolonged stay of lipiodol in the spinal canal ultimately prove to be entirely harmless (as seems possible), then there should be no drawback to its use. The value of lipiodol in cases where it is indicated, overwhelms these objections which then become of minor concern. If a tumor is present it can always be located with absolute precision by lipiodol. The density of the shadow is most striking. Its employment makes the diagnosis and localization almost fool-proof. Surely the possibility of error in localization when properly employed, is less than in all other methods combined. It can almost be said that little information other than that obtained from the use of lipiodol is necessary for the localization, even the diagnosis of a tumor. And doubtless one can exclude spinal cord tumors with equal certainty when the passage of lipiodol is unobstructed. It would be difficult to imagine that a tumor which gave symptoms could be present if lipiodol passed freely from the cisterna magna to the caudal end of the spinal canal. It is in those cases where a tumor does not exist that one need consider the objection, as yet theoretical, to the prolonged stay of lipiodol in the nervous system. When a tumor is exposed at operation, the lipiodol can be removed; but when a tumor does not exist the lipiodol must remain.

It is entirely possible that lipiodol might locate a block earlier than air, for the viscosity of the oil would probably prevent, or at least retard, transit of the oil around a tumor which air could still pass. However, we have had no opportunity of making a practical application of this hypothesis. In all of our certified tumors in which air has been used, there has been a total subarachnoid block except in one instance when an abnormal pressure was used; and in none of the cases in which a tumor has been excluded by the interpretation of the air injection, has a tumor since appeared. Our inference from this fact would be that except when tumors arise within the cord, occlusion of the spinal subarachnoid space, demonstrable either by air or lipiodol, would occur soon after sensory and motor symptoms appear.

The indications for air injections are much the same as for lipiodol. The advantage of air over lipiodol is that it is quickly absorbed. The principal disadvantage is that in localizing the level of a tumor the air shadow is far less sharp. Whereas the lipiodol shadow is as striking as a bullet, the X-ray

plates must often be carefully scrutinized for the air shadow. Unless the location of the tumor is known to be within a restricted part of the spinal cord (a determination which can be roughly made by measuring the volume of fluid in the spinal canal), the search for the air shadow would be very difficult. Air shadows in the cervical region are too uncertain to be reliable because of the strong superimposed shadow of tracheal air. Usually a tumor level can be clearly shown in the thoracic and lumbar canal. For tumors caudal to the site of lumbar puncture, an air shadow could define a tumor only if the pelvis was raised, but none of our tumors have been in this region. For localization of tumors which are known to be present, lipiodol is, therefore, far superior to air. Moreover, an inferior X-ray plate will make a better localization with the use of lipiodol than the best X-rays after the injection of air.

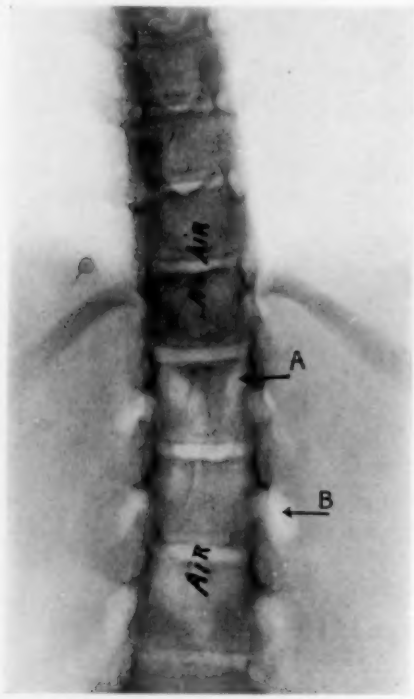

FIG. 16.—X-ray photograph (not retouched) showing the localization of a spinal cord tumor after injection of air. Arrow A shows the conical shadow of the tumor situated in the lumbar enlargement; arrow B shows dilated pouch of a spinal nerve resulting from the increased pressure of hydrocephalus. It will be noted that the entire vertebral column below arrow A is light, owing to the presence of air. For two vertebræ above the air shadow it is dense because there is a tumor and no air. Above the tumor zone the inter-laminal spaces show, though far less distinctly than the air column below the tumor. It will be noted that there are three pouches at the entrance of the spinal nerves on the left, and four on the right—the fourth being opposite the tumor and is, of course, in continuity with the column of air below the tumor.

The greatest use of air is in the diagnosis or elimination of tumors; its localizing value is subsidiary. It is extremely simple, and except for a slight transient headache is without harmful effect. Air will apparently diagnose or eliminate tumors with a certainty equal to that of lipiodol, and it has the added advantage that no foreign material remains permanently in the central nervous system.

Our present attitude toward the diagnosis and localization of spinal cord tumors may be summed up as follows:

1. A careful history and neurological examination will be sufficient both for diagnosis and localization in over 90 per cent. of the cases of spinal cord tumor. The importance of a painstaking examination is shown by the fact that in five of our cases sensory changes were missed by two observers and picked up by the third, who thereby made it unnecessary to use air or lipiodol for localization. By using air or lipiodol (only when required) the diagnosis and localization can be made in the remaining 10 per cent. of these cases.

2. Use *air* to *diagnose or eliminate* a tumor when the neurological examination is not adequate for this purpose.

3. Use *air* (same injection) to *localize* a tumor when it is possible.

4. Use *lipiodol* for localization when a tumor is known to be present and where other means fail. The lipiodol can then be removed at operation.

5. Lumbar puncture alone is not a procedure of merit. The limited information it yields is overbalanced by the potentialities of serious harm. If used in conjunction with air or lipiodol, the information obtained is greater than the possible injury. Any injurious effect from lumbar puncture can be corrected by immediately removing the tumor.

6. Lumbar puncture is necessary for air injections. Ayer's cisternal puncture is far superior for the lipiodol test.

7. The importance of a dry lumbar puncture tap is indicated in three cases, but there is danger of error in the interpretation of purely negative evidence. It is safer to use lipiodol when in doubt.

It should be emphasized that these impressions are formulated when lipiodol has been used for only a short time and when its ultimate results have not yet been demonstrated. Should Sicard's early impressions not be modified, it is quite probable that lipiodol may eventually be used to the exclusion of lumbar punctures and air injections. Our sole objection at the present time is that it requires the unnecessary, even if not obviously harmful, inclusion of a foreign body in the nervous system.

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SPASMODIC TORTICOLLIS

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This paper is based upon a study of thirty-two cases of spasmodic torticollis. All of these cases were operated upon one or more times by either one of us, and observed both before and after operation. In this study we have been most fortunate in having the benefit of the advice and assistance of Dr. H. M. Thomas, Neurologist to the Johns Hopkins Hospital, who has seen and examined practically all of our cases.

Of these thirty-two cases, thirty-one have either been seen personally, or have been heard from by letter within a short time, so that the late results of the operation are well known.

In this study we shall concern ourselves only with the spasmodic variety of torticollis, leaving out of consideration, except for the purposes of classification, the more common congenital and other acquired forms.

The disease under consideration derives its name from a sudden convulsive movement or spasm of one or more muscles or groups of muscles that move the head on the body. In aggravated cases other groups of muscles may also become involved, *e.g.*, those of the shoulder and arm, and those that have to do with speech and deglutition. Two of our cases showed definite changes in the voice. In one, the muscles of the chest were affected, and in another the muscles of the abdomen and leg, while four showed involvement of the shoulder and arm. This would seem to indicate that we are dealing with a more or less complex process. This idea is still more accentuated by the fact illustrated by several cases in our series, namely, that not infrequently when one muscle or group of muscles—those primarily involved—are put out of commission by operation, the affection immediately manifests itself in an adjacent set of muscles, or may even involve the opposite side. This fact adds greatly to the uncertainty of the result, and renders unsatisfactory any form of surgical treatment hitherto employed. Either for this reason or because incomplete operations have been performed, in a comparatively large proportion of cases repeated operations have been found necessary before a cure has been effected. Two of our series were operated upon four times; one, three times; and eight, twice, before relief was obtained. This was particularly true of the earlier and more or less incomplete operations in the series, that is, before a satisfactory technic had been developed.

Another observation of importance was the fact that while moderate improvement, as a rule, has followed immediately upon the operation, in a fairly large proportion of the cases the improvement did not reach its full extent for a considerable time—from six months to two or three years. This

fact at once raises the question of the actual relationship between the operation and the result in those cases where the improvement has been so long delayed. At the present time no satisfactory answer to this question can be given. It will be sufficient simply to call attention to the fact that, while occasionally cases of this very troublesome affection do recover spontaneously, or after one form of treatment or another, nevertheless, a large percentage of our cases had been under observation and treatment for long terms of years without benefit until operated upon by the radical method.

Various types of this disease have been differentiated from time to time, depending largely upon etiological considerations, *e.g.*, the congenital, infectious, traumatic, compensatory, neurotic or mental, and spasmodic. It is an undoubted fact that certain children are born with abnormalities of one kind or another giving rise to wry neck and due, in all probability, to a faulty or constrained position of the fœtus *in utero*. But the pure congenital form is certainly rare. More common are the forms of wry neck—often wrongly called congenital—that develop soon after birth and probably result from injury received at that time to the sternomastoid or other muscles or nerves of the neck, or in connection with congenital spinal deformity.

Those cases which cannot be classified in any of the groups just mentioned are, by most authors, included under the general term of neuroses or psychoses. The differentiation of this general type and various forms of tic from the spasmodic form with which this paper is chiefly concerned, is by no means always either easy or possible; but we believe that the evidence is sufficient to justify the assumption that such a difference does actually exist, even if the present state of our knowledge of the subject does not always admit of a positive conclusion.

The development of the surgical treatment of torticollis from the first reported open section of the sternomastoid muscle performed for the relief of this affection by Isaac Minnius, a German army surgeon, in 1641, to the introduction of modern methods, is of sufficient interest perhaps to warrant a brief review. In this same century Hendrick van Roonhuyze, among other difficult and unusual operations, reported several performed for wry neck. But the operations consisted in little more than the section of the affected muscles, at that early date quite a formidable undertaking.

During the Eighteenth Century interest in the subject remained alive, although advances in the knowledge and treatment amounted to practically nothing. However, in 1737 Jaeger took "Torticollis" as the title of his inaugural thesis as Professor of Surgery in Vienna. Dupuytren, in 1812, had the distinction to be the first to perform closed tenotomy of the sternocleidomastoid muscle at its sternal origin. This operation, owing to the reputation of its originator, had considerable vogue for a time, but several reported fatalities due to injuries to the underlying vessels discouraged its further use and made the open operation the method of choice.

The greatest and most far-reaching step in advance along these lines up to that time, namely, the section of the spinal accessory nerve, has been

generally credited to Campbell de Morgan, of London, who performed this operation successfully in 1866. However, Bujalski, in 1834, resected both spinal accessory nerves in a case of bilateral spasm of the sternomastoids. His report apparently made no impression, and the method for some time gained no popularity.

But following de Morgan's paper, for the next twenty-five years or so the operation was performed with increasing frequency. Charles Bell, among others, reported several cases. Various modifications of the method of attack on the nerve supply to the muscles were made by different surgeons. Nerve stretching, for instance, as suggested and practised by Southam, had many advocates. Collier suggested constriction of the nerve trunk with silver wire, and reported a few cases treated successfully in this way.

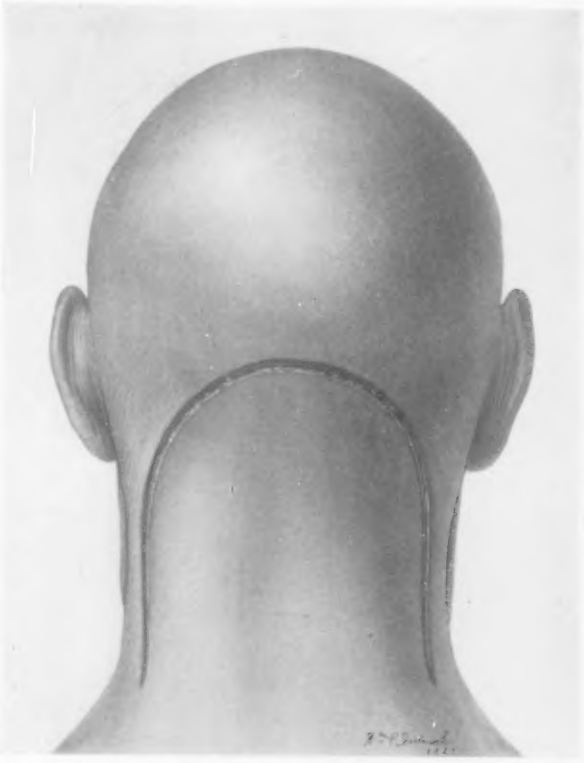

FIG. 1.—Incision. Lower limit, level of angle of jaw; upper, 1½ cm. below occipital protuberance.

Multiple myotomy was also employed extensively during this period, notably by the elder Gross.

The surgical attack upon this affection, either by the nerve or by the muscle route, represents fairly clearly the opinion held respectively by American and English surgeons on the one hand, and the German surgeons on the other; for while the former preferred neurectomy, Kocher and Mikulicz strongly advocated muscle section as the operation of choice. Their success was in all probability largely contributed to by the unavoidable division of the nerves in their extensive muscle resections. In 1891, W. W. Keen first published the results of an operation performed by him in the previous year, curiously enough at the suggestion of Weir Mitchell, upon one of Dercum's patients. He divided not only the spinal accessory nerve, but the posterior divisions of the first three cervical nerves as well. This was the first really carefully studied and scientific attempt to treat the disease on a rational basis. In his report Keen described the surgical procedure in considerable detail. The

operation involves exposure of the first three cervical nerves through a transverse incision across the back of the neck, beginning at a point 2 cm. below the lobule of the ear. Section of the intervening muscles and careful location of the posterior divisions of the first three cervical nerves are described. Keen was convinced from his observations that cutting of the muscles was merely an incident to the real object, which is division of the motor nerve supply.

Gardner and Giles, of Australia, claim priority of three months over Keen for this operation, but their report was not published until 1893, two years after Keen's publication. Keen's suggestion was rapidly taken up both by American and British surgeons, and since then surgical literature has contained, from time to time, reports of isolated cases and groups of cases treated by operative methods more or less closely patterned after the method suggested by Keen.

In 1895, Mikulicz described the so-called "myomectomy" operation, in which he excised the lower two-thirds of the sternocleidomastoid muscle. The muscle is freed from its sternal and clavicular attachments and a portion excised, particular pains being taken to avoid the spinal accessory nerve.

In the following year de Quervain, working with Kocher, published the latter's operation of multiple myotomy. Two incisions are described as necessary in the carrying out of this procedure; the first is for the division of the sternomastoid, and the second, a transverse incision across the back of the neck through which are divided the muscles overlying the sub-occipital triangle. Kocher made a particular point of dividing the fibres of the inferior oblique in addition to the long external group, convinced that this muscle played the most important rôle in rotation of the head. De Quervain believed that the division of the muscles, by interfering temporarily with the cortical stimuli, would prevent the muscle "habit" from returning.

In the past few years no particular advance has been made and Keen's operation still stands as the basis of the great majority of surgical procedures directed against this disease, though Kocher, writing again in 1912, still maintained that multiple myotomy possessed great advantages over all other operations. McKenzie in the past year has advocated intrameningeal division of the spinal accessory nerve and upper three cervicals for torticollis. This means, however, an unnecessarily dangerous method of resection, and particularly so in view of the results set forth below, which have been attained by a much safer procedure.

The particular operation put forward in this paper is but a further development of Keen's idea. The special advantages claimed for the method to be described later are that it provides ready approach to and satisfactory exposure of the structures to be dealt with. The trouble with most of the operations hitherto described is that they fail to provide adequate exposure of the nerve trunks. The success of the operation depends largely upon the ability to resect these nerves after they have been accurately identified. By this method opportunity is afforded the surgeon to excise the nerve supply of all

the offending muscles together with the section of those muscles if desired, thus insuring the complete and permanent cessation of spasm in them. This method possesses the additional advantage of affording access to both sides, a point first emphasized by H. M. Thomas, which experience has shown to be necessary in most cases.

To-day we are apparently as far from knowing the real cause or causes of spasmodic torticollis as were surgeons one hundred years ago. Innumerable suggestions have been made as to its etiology, many of them quite fanciful and bizarre, all of them without definite scientific proof. All authors are apparently agreed upon one point at least, namely, the frequent presence of some pronounced neurotic or psychopathic element. This undoubtedly is a factor of importance in some cases. Brissaud especially insists upon it, and the so-called mental type ("type de Brissaud") bears his name. The French School of psychiatrists and surgeons largely follow his lead. He treated cases with psychotherapy with apparent benefit, and also reported cases cured by hypnotism. Oppenheim believes in the hypothesis that "the cerebral cortex, particularly in the area concerned in the movements of the neck, is permanently at fault." But this in no wise explains the exact nature of the mental or physical process which makes possible this special spasmodic manifestation.

Schaller reports two interesting cases which surgery had failed to benefit. Psychotherapeutic measures brought great relief. On the other hand, surgeons with experience in this condition have observed many cases where previous psychotherapeutic measures had completely failed. Our series contains several such. Schaller says, "Torticollis is to be classed very often as a true tic, and a careful differential diagnosis must be made between true spasm and this condition." Our experience leads us to doubt the truth of this observation. Martini and Berterini express the view that: "Spasmodic torticollis is a state of irritation of the reflex arc independent of psychic effort." But this does not explain the source or nature of the irritation.

Gowers says that "any case in a woman under thirty may be hysterical." Cruchet draws attention to cases in which the slightest pressure of the patient's finger against the pull of the muscles will overcome the spasm. This group he thinks must be mental, but a possible explanation is the practical application of Sherrington's law.

Several cases in our series, in the early stages of the disease, exhibited this same phenomenon of the control of the spasm by merely holding the tip of the finger to the chin as described by Cruchet; but this procedure tends to become less effective as the disease progresses. He also speaks of the "professional type" where in certain occupations constant effort is exerted in holding the head in one position. Watson Cheyne leans towards the idea of a "craft palsy" (occupation neurosis) and cites the case of a tailor who always turned his head when tightening a stitch and who later developed a spasm of the muscles involved in this action. Many other cases of a similar character have been reported in the literature. Our series includes several

such. W. W. Richardson adds to this general idea a neuropathic heredity. Tubby thinks there is always a mind element involved, but neither can offer any very definite scientific data upon which to base his hypothesis. To the broader view that a neurotic temperament plays an important part in some as yet unknown organic pathological change, we find many strong adherents.

Toxic irritation of the central nervous system due to chronic infection has also been regarded by some as one of the most plausible explanations. Following this hypothesis, teeth and tonsils and other possible foci of infection have been removed without appreciable effect. In the majority of cases, no adequate exciting cause whatever is to be found, and recourse must be had to the rather non-committal explanation of Taylor, namely, that "mental perturbation, over-action of the muscles, and habit are responsible." Poore cured one severe case with anti-luetic treatment. Osler believed malaria to be a factor. Curiously enough, six of our cases give a history of previous malarial attacks. Lister reports a case following chorea in a boy seventeen years old. We have a similar case. Sources of reflex irritability have been sought, especially in the eyes and ears. An important etiological factor in a small number of cases may be refraction errors or muscular insufficiency.

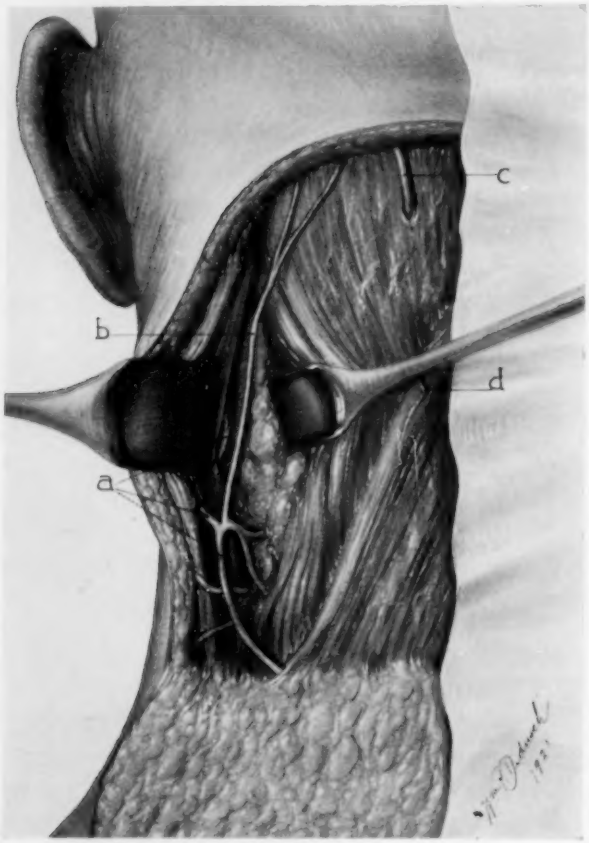

FIG. 2.—(a) Spinal accessory nerve; (b) lesser occipital nerve; (c) greater occipital nerve; (d) third cervical nerve. View after skin and subcutaneous tissues have been turned back.

In a paper by Posey he quotes Duane as follows: "Tilting of the head towards one's shoulder takes place to obviate the diplopia. This attitude may be maintained so persistently as to cause an actual wry neck." Posey reports seventeen cases of insufficiency, in only one of which there was an actual wry neck, and this in a boy eleven years old. The diagnosis was "insufficiency of the superior rectus and the right external oblique." Tenot-

omy of the oblique tendon was performed. Two months after operation no appreciable change was noted in the position of the neck. Bordley (personal communication) is quite right in insisting that an examination of the ocular muscle balance should be made in all these cases. But that this factor plays only a minor rôle in the etiology, is indicated by the fact that only a single case in our series showed any appreciable defect in vision. He reports two cases associated with disturbance in the eye muscles, in which the inferior oblique was divided. One was cured, the other unrelieved. Worry has been noted by several writers as bearing some causal relationship to the disease, but no conclusive evidence has been advanced to support their position.

So far as our series is concerned, no factor of general etiological importance was developed, although instances of almost all of the commonly assigned causes were observed.

Occupational strain seemed to play a definite part in the antecedent history in four cases.

Four of our series were physicians, two architects, six were business men, twelve housewives, one schoolgirl, one judge, one teacher, and two laborers; one had no occupation.

Heredity seemed to play but a small part. The mother of one case had been similarly affected, and there was a marked neurotic family history in two. Of the patients themselves, in ten a marked nervous element was noted; four had had actual nervous "breakdowns," so-called, four had had typhoid fever, four chronic tonsillitis.

In eight cases the trouble seemed to date definitely from some particular cause: severe trauma to the neck, two cases; hard work, involving unusual muscular strain, two cases; typhoid, one; tonsillectomy, one; osteopathy, one; chorea, one.

The trouble is very persistent and chronic, as shown by the fact that in ten of our series it had lasted for varying periods from three to forty-one years, and in twelve had existed for over six months but less than one year.

The disease is characterized by remissions and exacerbations without apparent cause, except that rest in bed with the head supported is often followed by mitigation in the severity of symptoms; while active exercise—especially walking—emotional excitement, embarrassment, and fatigue seem to aggravate the muscular spasm.

The pathology of spasmodic torticollis is even more obscure than the etiology, since no actual causative lesion has as yet been demonstrated. The trouble, whatever it is, must be either of central or peripheral origin, with the weight of authority, at the present time, rather favoring the former.

We are able to find in the literature the report of an autopsy in but a single case of this affection, that of Kollarits. The reason for this is obvious; the disease itself is never fatal, and its operative treatment is followed by a singularly low mortality rate considering the magnitude of the surgical procedure as now advocated and practised for its relief. The report of the autopsy findings in Kollarits' case showed little but degenerative changes,

not very pronounced, in the posterior columns of the cord. The numerous specimens from the cortex, pons and upper part of the medulla showed nothing. In the medulla, the tract of Goll showed slight degeneration. In the cord slight changes were observed in the posterior fasciculi only. Since this patient died of inanition, the question at once arises as to whether or not these changes may not have been influenced by this fact.

Volkmann reported finding a large amount of connective tissue in the excised muscles. This has been mentioned repeatedly since, and has been found in a majority of our cases where the tissue was examined. The cervical lymph-nodes, which are usually found to be definitely enlarged, particularly the deep chain, show a simple hyperplasia without other pathological changes. Due to the lack of necropsy material, the nature and position of the central lesions—if there are any such—are purely a matter of conjecture. Starr thinks that the muscle complex suggests a cortical origin. Tubby believes some cerebral lesion, due possibly to sclerotic changes in the vessels, may be responsible. Maurice Richardson concluded that if the lesion were central, it must follow the muscular movements, attempting in this way to connect refractive errors with the underlying cause. W. W. Richardson says that although the exact nature of the nerve lesion is not understood, it is probably central, either spinal or cerebral. The involvement of a group of muscles, he thinks, would indicate higher centres; whereas single muscles would rather point to lower centres, either in the bulbar or spinal gray matter.

"To say that it is a condition of irritation in the nerve nuclei is of small help, since we are ignorant of what such irritation may consist. The most reasonable hypothesis, as maintained, for example, by Brissaud and Oppenheim, is that the cerebral cortex, particularly in the area concerned in the movements of the neck, is primarily at fault." (Taylor, in *Osler's Modern Medicine*.)

Attention has been called by certain observers, notably Marie and Léri, to certain changes in the cervical vertebræ. They describe certain irregularities in outline of the bodies of the vertebræ in the form of bony excrescences or lipping of the edges, as seen not infrequently in chronic rheumatic affections involving the spine. These are shown up particularly well in stereoscopic X-ray plates. In only one of our series was any such abnormality of the vertebræ noted.

Byrnes has described certain changes that he has observed in the spinal accessory nerves removed from a case in whom the spasm had existed for four years. He observed swelling and degenerative changes in the axis cylinder and axones. No connective tissue induration, or any evidence of acute inflammation was observed. There was a complete absence of myelin. The muscular tissue removed showed the degenerative changes usually described by other observers.

Rosenow has recently reported some interesting and suggestive results that he has obtained. He has been able "to produce in animals tic-like movements of the head as a common sequel to attacks of encephalitis induced by the intra-

cerebral injection of a somewhat peculiar streptococcus isolated from cases of human encephalitis." His report is only a preliminary one, and it is too early as yet to draw any definite conclusions, but it opens up a most interesting field for further development.

From the variety of opinions expressed, and hypotheses advanced, it can readily be seen that we possess no accurate scientific knowledge as regards the pathology of this perplexing condition; and until this knowledge is forthcoming, the pathology must remain in the realm of conjecture.

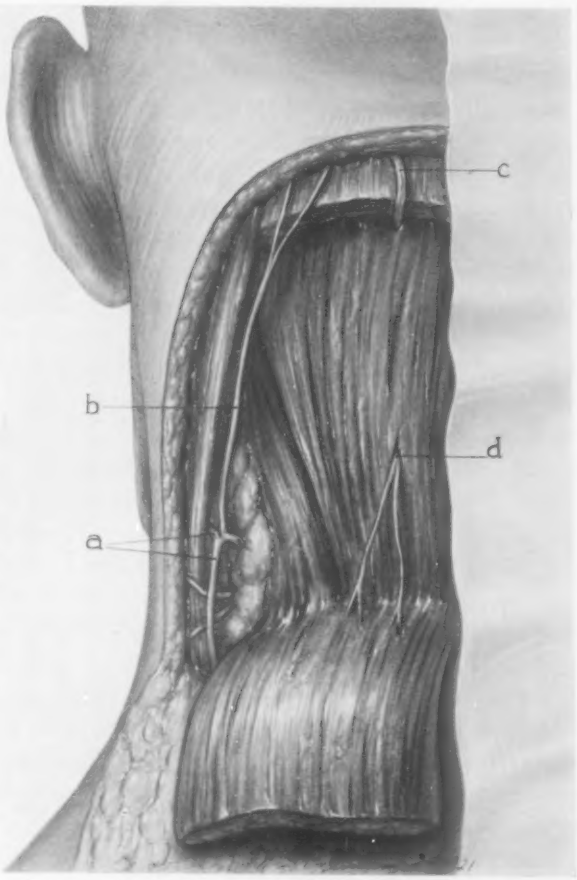

FIG. 3.—(a) Spinal accessory nerve; (b) lesser occipital nerve; (c) greater occipital nerve; (d) third cervical nerve. Splenius and trapezius muscles have been divided and turned back.

In the typical case the diagnosis of this affection can usually be readily made, although in certain cases difficulty may be experienced in differentiating it from true tic or the spasm of the neck associated with general nervous diseases—athetosis, chronic chorea and the like. The striking characteristic of the disease is the involuntary movement of the head caused by the spasmodic contraction of the muscles of the neck, and in the majority of cases it is confined to these muscles. This may vary from a slight nodding or jerking movement scarcely noticeable, to contractions and contortions of extreme violence and not infrequently painful, involving not only the muscles of the neck and face, but in certain severe cases those controlling speech and deglutition, the shoulder muscles, the chest and abdomen, and in isolated cases, even the lower extremity have been involved.

The spasms are entirely involuntary and are either clonic or tonic in character. Not infrequently both are present in the same case, while on the other hand the muscular contractions in true tic always have a voluntary element and are rarely confined to one group of muscles.

The most characteristic position assumed by the patient is extension of the neck, with the head drawn over toward one shoulder, the face rotated to the opposite side and the chin elevated. However, many variations from this position are observed, the most frequent perhaps is that known as the retro-capital, where the head is drawn forcibly backward, either with or without rotation. In cases of long standing the prominent features not infrequently observed, in addition to those just mentioned, are facial asymmetry, together with well-marked hypertrophy of the muscles involved. Spasm of the facial musculature is rarely observed in our experience.

In doubtful cases, a hereditary neurotic taint, a history of certain postural occupations or antecedent factors, such as infections, errors of refraction, disarrangement of the normal balance of the muscles of the eye, nervous overstrain, and trauma have been mentioned by different authors as causative factors, and should be given due consideration.

Medical treatment in almost every conceivable form has been tried and found wanting with discouraging regularity. From time to time occasional benefit has been claimed from some particular drug or form of therapy. The various hypnotics and narcotics are extremely dangerous, for obvious reasons, particularly their tendency toward habit forming in a chronic disease such as this. Cross, in 1880, reported a case which represents fairly well the therapeutic possibilities. The treatment included the administration of the alkalies, iodides, bromides, colchicum, quinine, arsenic, valerianate of zinc, and cannabis indica; external remedies such as iodine, sinapism, atropine ointment, compound camphor, belladonna and aconite liniments. Due attention was paid to general hygienic measures. No benefit was derived from any of these, so Noble Smith performed a neurectomy of the spinal accessory nerve in this case, and effected a cure. Massage occasionally proves helpful. Mechanical supports are of little use as a rule, although many different kinds have been recommended. The muscles involved show no change to electrical reaction. Electrical therapy has proved of little or no value. Richardson and Walton studied carefully the effect of electricity and confirmed this view. Much was expected from alcohol injections, but extended use of this treatment did not confirm earlier expectations. Hydrotherapy and massage, psychotherapy and reëducation, and many other therapeutic measures have been tried from time to time, with disappointing results on the whole. Stress is laid, particularly by French writers, upon psycho-analysis in the so-called mental type of torticollis, and they report some cures. Clark also favors this method and reports three out of five cured, all of them severe, and in whom all sorts of physical and drug treatments had been previously tried in vain. He insists that nothing but a complete reconstruction of the whole mental attitude can make these patients well.

Williams makes a strong plea for psychotherapy in all these cases, insisting upon the proposition that they are all amenable to this form of treatment. The difficulty is in its proper application, the length of time, expense incurred, etc.

We have already outlined the growth and development of the surgery of spasmodic torticollis. The more recent opinions in regard to the radical procedure are of interest. In the discussion which followed the reading of Keen's preliminary report of his operation before the Philadelphia Neurological Society in 1890, it was considered by several eminent surgeons who took part as an unnecessarily severe method for the cure of the condition in question. The general opinion from 1890–1895 was that division of the spinal accessory nerve should be tried before the more radical operation was attempted. Eliot believed that division of the spinal accessory nerve tended to relieve an active posterior group spasm. Powers believed that the first four cervicals should be divided, whereas the majority of operators confined their efforts to the upper three. Chiene felt that if neurectomy should fail and the patient's life still be miserable, the surgeon should not hesitate to expose the cortex and remove the portion of the brain involved. Horsley was of the same opinion, but no such cases are reported in the literature. Later still, Tubby writes of the disappointment of all half-way measures. Starr thinks little of surgery and says in general that, "treatment is unsatisfactory because we are ignorant of the cause of the disease." This is quite true, but since, as we have just seen, medical and other measures short of surgery offer so little, we are justified in taking even extreme measures, where less radical ones have proven unsatisfactory in providing relief from such a deforming and disabling condition as the one under consideration. With this idea in view and after experiencing failure with incomplete operations, we have been forced to try, especially in severe cases, more radical methods.

In planning the operation we have endeavored to make it sufficiently comprehensive to include all the offending structures, on both sides instead of only one, as experience has taught us that in the majority of cases sooner or later both sides become involved. The operation about to be described is based upon the anatomical relations as observed in operations performed upon our series of thirty-two cases and in the dissecting room findings in approximately fifty cadavers. After having tried various positions, we now employ that known as the cerebellar position, the patient lying prone with the shoulders elevated, the head slightly flexed and projecting over the end of the operating table and supported on a rest. The usual aseptic technic is employed.

The incision should be made along the posterior border of the sternomastoid muscle (Fig. 1), beginning at a point two finger-breadths below the level of the angle of the jaw and continuing upwards along the edge of the muscle to a point about the level of the lobe of the ear, then curving over toward the midline to a point about two finger-breadths below the occipital protuberance, thence carried across the midline, following the same general direction as just described, in reverse order. When completed, the incision is in the form of an inverted "U". Reflect back a flap of skin and subcutaneous tissue, taking care to identify and avoid the lesser occipital nerve, which is quite superficial and lies along the posterior border of the sterno-

mastoid muscle, in its upper half. Having exposed and identified this nerve, follow it down to the point where it emerges from behind the posterior border of the sternomastoid muscle (Fig. 2). By retracting the sternomastoid muscle, the anterior divisions of the second, third and fourth cervical nerves now come into view, together with the chain of deep cervical lymph-nodes. A little further in front of the plexus, and consequently a little deeper in the wound, will be found the trunk of the spinal accessory nerve where it emerges from the body of the muscle. The nerve having now been definitely identified (and here as with all other nerve trunks involved, direct stimulation with a bipolar electrode makes the identification absolute) can be resected at any point desired. No effort should be made to save the sensory branches of these nerves as, in Thomas's opinion, both efferent and afferent pathways should be interrupted. Search should next be made for the great occipital nerve where it emerges through the fibres of the splenius, about one cm. from the midline, and just beneath the skin incision. Having identified this nerve, divide transversely at this point the trapezius and splenius muscles (Fig. 3), exposing the fibres of the complexus, which is easily recognized. The fibres of this muscle are divided in turn throughout its whole thickness in the same plane as the skin incision, and it is then reflected backward in the same way, care being taken all the while to preserve the great occipital nerve which lies immediately below it. This exposes the two recti muscles, major and minor, and the superior and inferior oblique (Fig. 4), each of which can be distinguished by the direction of its fibres and their common point of origin. The trunk of the great occipital nerve should then be traced down to the

FIG. 4.—(b) Lesser occipital nerve; (c) greater occipital nerve; (d) third cervical nerve; (e) first occipital nerve; (f) branch of venous plexus. All posterior muscles have been divided and turned back, exposing the sub-occipital triangle.

point where it emerges from the vertebral foramen at the lower border of the inferior oblique muscle. At this point will be found its anastomosis with the suboccipital nerve running across the body of the muscle to the point where it is given off from the first cervical nerve in the suboccipital triangle.

The great occipital nerve should be resected below the point of anastomosis with the suboccipital. The latter can then be traced out in the suboccipital triangle as it emerges between the vertebral artery lying deeply in the triangle and the upper border of the inferior oblique muscle. Its branches to the recti muscles and the superior and inferior oblique muscles are given off here, and the main trunk of the nerve can be readily resected at this point. Care should be taken not to injure the vertebral artery, which may be identified as it lies on the floor of the triangle. The splenius and complexus muscles should be reflected sufficiently to allow the exposure of the third cervical nerve where it emerges a finger-breadth below the great occipital. At the level of the second and third cervical nerves is located a venous plexus of considerable size which may give rise to troublesome bleeding if care is not taken to avoid or control it, which, however, can be readily done. The third cervical nerve should be resected where it emerges from the vertebral foramen, as it supplies fibres to the overlying muscles (splenius, trapezius, and complexus). After the trunks of the three upper cervical nerves have been resected as described, the muscles may be replaced, layer by layer, and held in place by a few stitches, and the wound closed in the usual manner. In our earlier operations we excised portions of these muscles, but subsequent experience has shown that with complete resection of the nerve supply this rather mutilating procedure may be omitted. Until recently we have always inserted a drain consisting of a small piece of protective at each corner of the incision, but with adequate hæmostasis this will probably be unnecessary.

Formerly we applied a plaster-of-Paris bandage reinforced with wooden splints, with the head in an overcorrected position; but this added greatly to the patient's discomfort and appeared to be rather a source of irritation than a help, and so was discontinued in favor of the ordinary gauze dressing and soft bandage, reinforced with light wooden coaptation splints if desired. Notwithstanding the great extent of the wound, the healing has been uniformly satisfactory and the resulting disability surprisingly slight.

The average time of the operation, doing two sides at one sitting, is one and a half hours. We would emphasize the fact that this operation should not be undertaken by any but an experienced surgeon, and only after thoroughly familiarizing himself with the anatomy of the part, as the success of the operation is dependent largely upon careful dissection and recognition of the different structures sought for. Careful hæmostasis in order to insure a clean, dry wound is essential for the easy recognition of the different structures, which facilitates greatly the performance of the operation.

From our experience with our group of thirty-two cases, we are convinced that the probable reason for failure to obtain cures is failure to identify and resect the nerves. We feel convinced too that it is impossible

to secure satisfactory exposure and identification of the nerves sought by any less extensive incision than that described.

Chiene says the prospect of a permanent cure of this affection by any method is in inverse proportion to the severity of the spasm, extent of the muscles affected, and duration of the disease. Starr gives a guarded but distinctly pessimistic prognosis.

These two opinions reflect very faithfully that held by physicians and surgeons alike, since no treatment up to the present time has given uniformly satisfactory results. Of our series of thirty-two operated cases, one has not been heard from recently. Of the remaining thirty-one, three are unimproved, sixteen have been improved but not entirely relieved, while twelve have been completely cured. It should be borne in mind that these operations cover a period of more than twenty years, that the earlier operations were very incomplete, and that the operation just described has been developed comparatively recently. It has been used in only a few cases, too few and too recent to enable us to pass final judgment on its merits, but in a sufficient number we believe, as compared with previously used and less radical methods, to justify its more extended use.

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PRACTICAL POINTS IN CONNECTION WITH GOITRE SURGERY

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It has seemed worth while to review the special points of practical importance in the surgical treatment of goitre as they have impressed themselves upon me in my clinical observations.

Before 1882, when von Rehn demonstrated the possibility of safely performing thyroidectomy for exophthalmic goitre, surgeons everywhere looked upon this condition as a positive contra-indication, and there still exists, especially in the mind of the general practitioner a certain fear against operative treatment in these cases.

Surgery of the thyroid gland has developed entirely since my entrance into the field of clinical surgery, 1891 being the date of my first operation for the relief of toxic goitre. The points to be discussed in this paper are consequently based upon a study of the literature of the subject from the publication of Kocher's first paper to the present time, together with the consideration of my personal experience in thousands of cases.

There seems at the present time to be no difference of opinion among surgeons regarding the treatment of simple goitre, a condition which requires surgical treatment only in case of discomfort from the size, or shape of the tumor, of interference with respiration, or for relief from an unsightly deformity. It will consequently, not be necessary to consider the treatment of simple goitre at the present time. For this reason only toxic and exophthalmic goitres will be considered in the present paper.

Selection of Cases.—In the selection of cases suitable for surgical treatment it is simply a matter of choosing the time of operation rather than the type of case, because practically every case of advanced toxic, or exophthalmic goitre will sooner or later require surgical treatment in order to restore reasonably good health. The well known fact that patients suffer from periods of exacerbation followed by periods of remission should be utilized to the great advantage of the patient, because the case that represents a serious risk during the period of exacerbation becomes a safe risk during the period of remission.

Absolute physical, mental and emotional rest during the period of exacerbation, together with the application of an ice collar over the neck, and an ice coil over the heart, and a non-stimulating, meat-free diet, with an abundance of distilled water and fresh air, will usually change the condition into one of remission in a relatively short time.

Since Plummer's vigorous support of the use of Lugol's tincture of iodine we have added this to the treatment apparently with good success. In case of doubt it is well to employ the metabolic test while the patient is being prepared for operation.

Occasionally the thought of the operation will suddenly increase the toxic condition, and in this case it is best simply to postpone the operation until the acute exacerbation has again subsided.

Occasionally we have observed such an exacerbation during the administration of the local anæsthetic, which has, however, usually subsided within ten or fifteen minutes so that the operation could proceed safely. In case the exacerbation has persisted, we have found it best not to perform the operation until a later date, when these patients have had no further recurrence.

Preliminary Ligation and Partial Operation.—Some years ago the advice of Theodor Kocher to perform preliminary ligation of one or more, of the four principal arteries, or to remove the gland in two, or more, partial operations, seemed indicated.

At the present time we never make the excision by taking away one lobe at the first sitting and the second lobe at a subsequent sitting, because our former experience seemed to show that the only difficulty we had following thyroidectomy came from post-operative hyperthyroidism, and that if we removed both lobes at the first sitting there was less likelihood of this condition because there was not enough thyroid tissue left to produce an excess of thyroid secretions.

The amount of thyroid tissue left along the posterior capsule amounts to about 15 c.c., which does not seem sufficient to produce post-operative hyperthyroidism. In case of doubt in patients in which this remnant of thyroid tissue is spread over a considerable area so that one might fear an acute absorption of substance on account of the great area of raw surface, we have tamponed this surface with gauze for a few days for the purpose of absorbing all of the secretions from the raw surface.

Occasionally a serious case seems to show alarming symptoms during the progress of the operation, and in these cases we simply tampon the entire wound with gauze and interrupt the operation at once, and close the wound several days later after the patient has fully recovered from the shock of the operation.

Preliminary Ligation of Vessels.—Very rarely a patient does not improve in a satisfactory way under the rest treatment described above, and in that case we may ligate first one and then the other of the inferior thyroid arteries, according to deQuervain's method described in a previous paper. We prefer this method because it reduces the blood supply to a much greater extent than the ligation of the thyroid artery and because it produces no deformity, as it can be done through a portion of the transverse Kocher incision to be employed later when the goitre is removed, while the ligation of the superior thyroid artery always produces a considerable amount of deformity. It has seemed to us in these cases of preliminary ligation that the fact of having had the experience of a painless operation under local anæsthesia removes the element of fear from the patient at the future operation, and this in turn reduces the likelihood of post-operative hyperthyroidism.

Anæsthesia.—Our experience has convinced us that patients operated for

toxic or exophthalmic goitre make a much more satisfactory recovery if operated under local anæsthesia with ½ per cent. novocain, than if operated under general anæsthesia. The amount of novocain solution, or one of its equivalents, need not exceed 120 c.c. of a ½ per cent. solution. We give ¼ grain morphia and $^1/_{150}$ grain atropin one and one-quarter hours before, and ⅙ grain morphia and $^1/_{200}$ grain atropin one-half hour before beginning the local anæsthesia. This quiets the patient, reduces the sensitiveness, and the atropin reduces the secretion of mucus in the pharynx during the operation.

In two instances we have observed convulsions, which subsided quickly under the inhalation of ether in one case. In the second case ether was not administered and the case succumbed to the convulsions.

Hæmostasis.—We still adhere to the rule laid down by Kocher thirty years ago that careful hæmostasis is one of the most important precautions to be taken throughout the operation. After the goitre has been removed and all the ligatures of vessels, connected directly with the gland, have been tied, we tampon the space between the anterior muscles of the neck and the stump of the thyroid gland with gauze in order to absorb any goitre juice on the exposed surface of the stumps, and to compress the capillaries to prevent oozing. This gauze is left in place for several minutes until all the small vessels on the external wound have been ligated. By this time the wound is perfectly dry and is ready for closure.

A small drainage tube is inserted into the wound through the middle of the transverse collar incision to permit any serum which may be secreted to escape in order to prevent possible absorption of secretion from the raw surface of the stump. This tube is removed on the second day, permitting the wound to close completely.

In cases in which only one lobe is enlarged at the time of the primary operation, our practice in former years consisted in leaving the other lobes undisturbed. It seems, however, that the removal of the large lobe causes a compensatory enlargement of the other lobe, and this may go on to a point where its removal becomes necessary. For this reason for a number of years we have systematically removed a portion of the other lobes, which has apparently prevented a recurrence.

After the operation the patient is placed in bed with the head of the bed elevated. She is given an abundance of distilled water to drink, also fruit juices, buttermilk, milk and gruel.

If the heart is rapid, or irregular, an ice coil is placed over the chest. If the patient is very restless $^1/_{100}$ grain of hyocin is given hypodermically, and if this is not sufficient, ¼ grain of morphin and $^1/_{150}$ of atropin is given hypodermically.

The technic of thyroidectomy has been so thoroughly established that its description need not be added.

With the careful selection of the time of operation, the avoidance of unnecessary trauma, and the precautions just enumerated, thyroidectomy becomes one of the safest operations in the field of surgery.

THE EXPERIMENTAL TRANSPLANTATION OF THE DIAPHRAGM AS AN ADJUNCT IN THE TREATMENT OF LESIONS AT THE LOWER END OF THE ŒSOPHAGUS*

APPLICATION OF THE METHOD IN A CASE OF CARCINOMA OF THE CARDIAC END OF THE ŒSOPHAGUS IN MAN

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The problem of resecting a tumor of the œsophagus and reëstablishing the canal has interested surgeons for many years—indeed, since about 1885. A truly enormous amount of experimental and clinical work has been done in an attempt to solve the problem, but as yet with very meagre results. In the whole history of œsophageal surgery a malignant tumor has been successfully removed from the thoracic œsophagus in the human being but six times,† and in only one of these was the canal reëstablished. The difficulties have been chiefly five. (1) The condition of the patient, which is generally poor; (2) the preservation of the blood supply of that part of the œsophagus which has been mobilized for resection; (3) a secure suture either between the ends of the divided œsophagus or between the œsophagus and some other viscus; (4) the bridging of a gap after the resection of a portion of the œsophagus; and (5) the prevention of a fatal intrapleural infection. It will not be necessary to go fully into these difficulties, for they are perfectly familiar to surgeons. They have, however, been so formidable that they have compelled surgeons to devise long, tedious and intricate procedures, either extrapleural or extrathoracic, for use in operations upon man. These have required a period of months to complete, and the patients subjected to them have usually died before they have been completed. Meanwhile, surgeons have continued in their efforts to find a simple and satisfactory intrathoracic method which might safely supplant the extrapleural or extrathoracic methods.

The simplest experimental intrathoracic method was first suggested by Biondi in 1896. He freed the œsophagus at the hiatus, drew the stomach through the diaphragm into the thorax, resected the œsophagus and anastomosed the upper end of the divided œsophagus with the stomach. The same idea with various modifications formed the basis of experimental work by Anschutz, Sauerbruch, Willy Meyer, Green and Janeway, Zaaijer, Omi, Enderlen, and Miller and Andrus. The method has been reasonably successful in dogs, but there have been the complications due to imperfect suture

* Read before the American Surgical Association, April 19, 1924.

† Since this was written, Eggers, of New York, has reported an additional successful case.

with infection, of dilatation of the transposed stomach and of diaphragmatic hernia. It has never been successfully carried out in man.

Doctors Andrus, Bell and I thought a wholly new approach to the problem might contribute something toward its solution. Instead of attempting an anastomosis between œsophagus and stomach within the thorax, we considered transferring the lower one-third of the œsophagus into the abdomen and performing the anastomosis there. The obvious advantages of such a procedure are that it permits a primary gastrostomy for feeding purposes; it avoids the transposition of stomach or intestine into the thorax, which is not well borne, and permits an anastomosis in the abdomen where infection, if it should occur, is less fatal than in the thorax. In order to convert the lower end of the œsophagus into an abdominal viscus, one must transplant the diaphragm upward; and having in mind a two-step procedure, our work naturally was divided into two parts: (I) to test the feasibility, safety and possible complications of transplantation of the diaphragm, and (II) to perform a successful intra-abdominal œsophagogastrostomy after resection of the œsophagus.

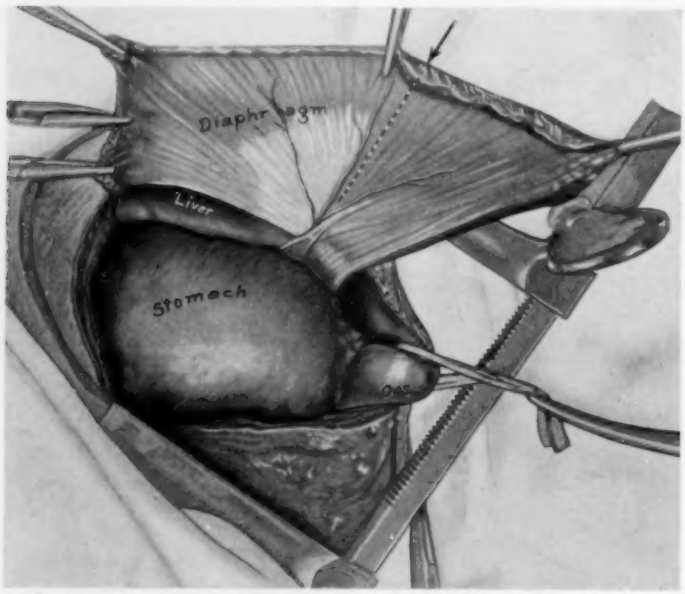

FIG. 1.—Transplantation upward of the diaphragm. The pleural cavity has been opened widely. The entire left half of the diaphragm including the crux has been incised close to its attachment to the thoracic wall and brought upward. The œsophagus has been freed from the diaphragm at the hiatus. The dotted line on the mobilized diaphragm indicates the position of the incision used in the formation of the new hiatus.

1. *The Transplantation Upward of the Diaphragm.*—(A) Procedure 1.—Under intratracheal anæsthesia a left intercostal incision is made over the ninth rib (which corresponds to the eighth rib in the human) and the thorax opened widely. The left half of the diaphragm is seized and incised close to and parallel with the thoracic wall, so as to free the entire half of the diaphragm, including the crux, from its attachment. The œsophagus is not freed from the diaphragmatic hiatus. The cut edge of the mobilized diaphragm is then brought upward four or five interspaces and sutured to the pleura, the bite of the needle including the intercostal muscles. The thoracic wound is closed. The object of this procedure was to test the technical difficulties and the possible complications of this simple operation.

Results.—This procedure, combined with division of the phrenic nerve, was carried out upon seven dogs. The only technical difficulty—and this is

not great—is the division of the diaphragm near the left crux, where an artery of considerable size may give rise to annoying bleeding. The animals recovered promptly from the operation, were active and ate and slept well. They were never observed to vomit their food. Although the left lung was in part compressed by the elevation of the diaphragm, they did not show any respiratory embarrassment. Of the seven animals, one died upon the fourth day after operation from an infection and one was killed in a fight upon the twelfth day. The remaining dogs were sacrificed upon the fifth, tenth, twelfth, sixty-eighth and seventy-eighth days after operation. In all seven animals the transplanted diaphragm was found firmly attached to the thoracic wall. Its musculature, due to the deliberate division of the phrenic nerve, had become, in the animals sacrificed late, markedly atrophic. There was no instance of diaphragmatic hernia.

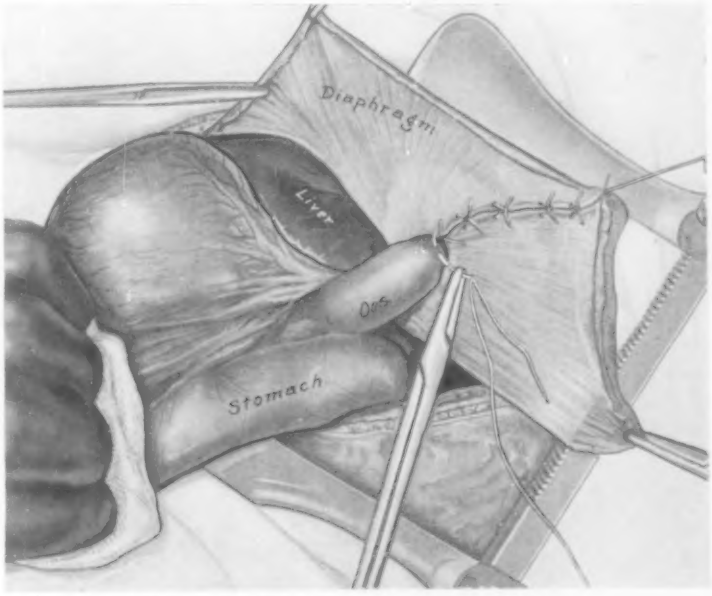

FIG. 2.—The formation of the new hiatus completed.

(B) Procedure 2.—Under intratracheal anæsthesia a left intercostal incision is made over the ninth rib and the thorax opened widely. The left half of the diaphragm is seized and incised close to and parallel with the thoracic wall, so as to free the entire half of the diaphragm, including the crux, from its attachment (Fig. 1). The œsophagus is freed from the hiatus and isolated almost to the bifurcation of the trachea. The diaphragm is split into its tendinous portion, so as to allow the formation of a new hiatus and the split resutured around the œsophagus (Fig. 2). The cut edge of the diaphragm is then brought upward four or five interspaces and sutured to the pleura, the bite of the needle including the intercostal muscles (Figs. 3 and 4). The result is a marked elevation of the diaphragm and the conversion of the lower one-third or more of the œsophagus into an abdominal viscus (Fig. 5). The thoracic wound is closed. The phrenic nerve was not divided.

Results.—This procedure was carried out upon nineteen dogs. The operation presents but two technical difficulties: the division of the diaphragm near the left crux, as noted under Procedure 1, and the satisfactory suture of the transplanted diaphragm to the posterior thoracic wall at the spine and around the aorta. It is here that the liability to the development of dia-

phragmatic hernia is greatest because of the absence of firm tissues to support a suture. The isolation of the œsophagus in the dog is very easy and can be accomplished without opening the opposite pleural cavity.

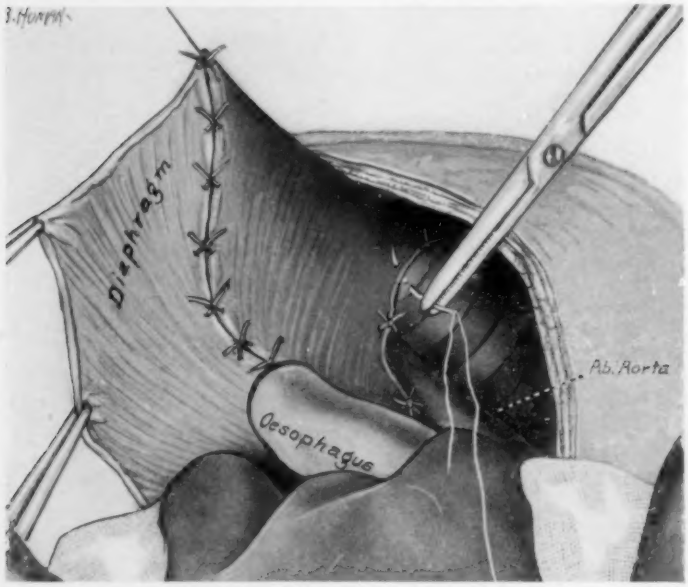

FIG. 3.—The suture of the cut edge of the diaphragm to the thoracic wall four to five interspaces above its original position.

The animals operated upon recovered promptly from the procedure and failed to show respiratory embarrassment or other untoward symptoms. Four of the animals were repeatedly fluoroscoped from forty-eight hours to eighteen days after operation and showed that the transplanted half of the diaphragm moved on inspiration and expiration, although its excursions were less than those of the normal side. Repeated observation at autopsy showed that the musculature of the transplanted diaphragm was normal in appearance and thickness.

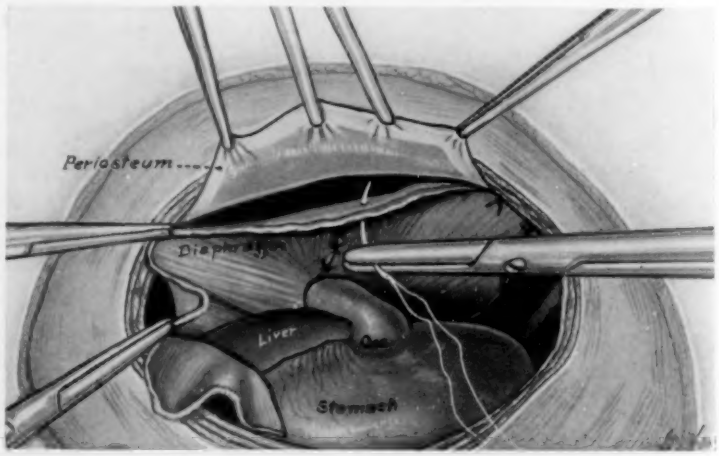

FIG. 4.—The transplantation of the diaphragm nearing completion.

Complications: 1. *Accidental.* Seven of the animals developed either a wound or an intrapleural infection, due to faulty aseptic technic. Three animals died on the tenth, twenty-second and sixty-third days after operation, and at autopsy were found to have strangulated, one from a hair-ball and two from bones. The point of lodgment of the foreign bodies was in the œsophagus at the new œsophageal hiatus. Two animals were found dead on the eleventh

and thirty-sixth days after operation, and at autopsy failed to show any lesions which could account for their death.

2. *As a Result of the Operation.* (*a*) *Diaphragmatic Hernia.* In two animals sacrificed several months after operation a single suture uniting the diaphragm with the posterior thoracic wall was found to have pulled away, allowing a small opening between the abdominal and thoracic cavities in one instance and between the abdominal cavity and posterior mediastinum in the other. In neither case had a diaphragmatic hernia resulted. In one animal death occurred on the thirty-sixth day after operation and at autopsy a diaphragmatic hernia involving the stomach and spleen was found. This is the only instance of diaphragmatic hernia in the series. Why in this animal the diaphragm had in part pulled away from the thoracic wall could not be explained. In no instance was the diaphragm sutured to the thoracic wall under tension.

FIG. 5.—Autopsy specimen showing the lower portion of that part of the œsophagus which has been transposed into the abdomen. The thread is attached to the costal margin. The transplanted diaphragm is above this level and does not show in the photograph.

(*b*) *Vomiting or Regurgitation.* The most constant complication of procedure 2 was the occurrence of vomiting. In fifteen of the nineteen animals more or less vomiting, with a tendency to lose weight, occurred. In four animals both vomiting and loss of weight were completely absent. The

vomiting was distinctly of the œsophageal type, a regurgitation of food immediately after its ingestion. Autopsies upon such animals several weeks or months after operation showed a slight narrowing of the œsophagus at the new hiatus, this narrowing apparently being due to the contraction of the diaphragm around the œsophageal wall. There was hypertrophy of the wall of the œsophagus above the point of constriction and, in a few instances, slight dilatation as compared with the œsophagus below the hiatus. No dilatation comparable to that seen in cardiospasm or cardiac obstruction in man was observed. In the four animals which did not vomit it was noted that the new hiatus was more loosely formed around the œsophagus. It is quite possible that our fear of diaphragmatic hernia was exaggerated and that we fitted the diaphragm too snugly around the œsophagus. The problem of forming a new hiatus sufficiently wide to prevent the occurrence of vomiting or the development of diaphragmatic hernia could, we think, be solved through the use of a cuff of fascia.

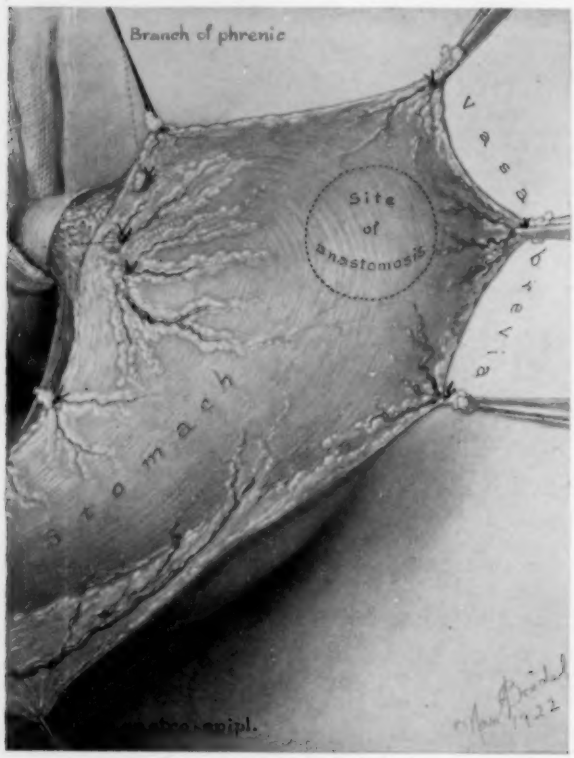

FIG. 6.—The stomach drawn into the wound, showing the site of anastomosis with the œsophagus. In our procedure the vasa brevia are not ligated as shown in illustration.

(C) Procedure 3.—This procedure differs from the preceding in that (1) the œsophagus is not dissected from its bed, but is simply freed from the diaphragm at the hiatus, and (2) the mobilized diaphragm is not split to form a new hiatus, but is brought upward to the desired level and sutured to the posterior wall around the œsophagus and aorta. The considerations which led to these modifications of procedure 2 were the occurrence

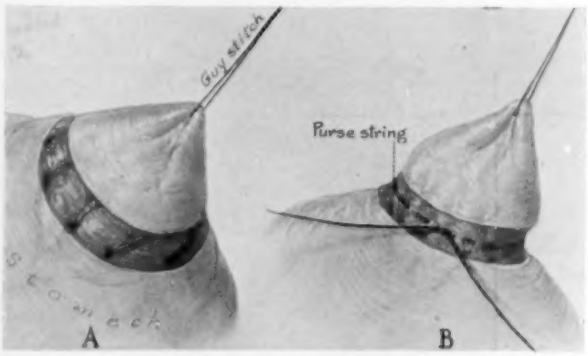

FIG. 7.—Preparation of the site for implantation in the stomach wall.

of gangrene of the œsophagus in a case of carcinoma, to be detailed later, and due, in our opinion, to the extensive mobilization in the first stage of the operation; and the occurrence of vomiting in the animals subjected to procedure 2, which we thought to be caused by constriction of the œsophagus at the newly formed hiatus. The procedure technically is simpler in some respects than procedure 2, but is more difficult, in that a secure suture of the diaphragm to the posterior thoracic wall around the œsophagus and aorta is less easily made.

Results.—Only two dogs were subjected to this procedure, too small a number from which to draw conclusions. A later report on this phase of the work will be forthcoming. Both animals recovered promptly from the operation and were never observed to vomit or regurgitate their food. They maintained their weight. They were sacrificed on the fifty-fourth and seventieth days after operation. One was found to have a diaphragmatic hernia involving portions of the stomach, small intestine and spleen. In the other the result was perfect.

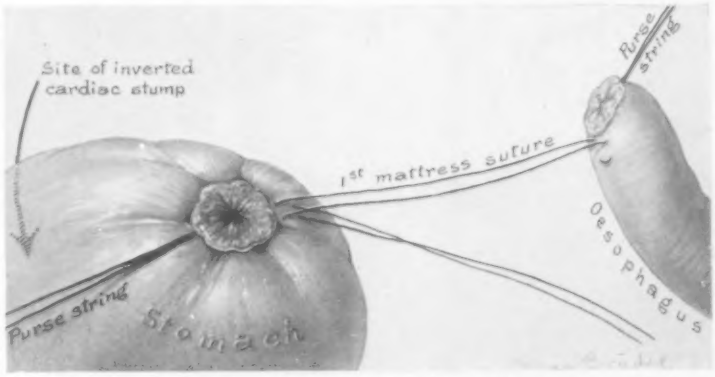

FIG. 8.—Beginning of the stitch anastomosing the œsophagus to the stomach.

II. *Intra-abdominal Œsophagogastrostomy.*—In the contemplated resection of the lower end of the œsophagus, procedure 2, or, should it prove more satisfactory, procedure 3, constitutes the first stage of the operation. The second stage consists of the resection of the œsophagus and the anastomosis between the cephalic end of the divided œsophagus and the fundus of the stomach. After a number of experiments the technic of œsophagogastrostomy, as described by Miller and Andrus,‡ but performed within the abdomen instead of within the thorax, was adopted as being most satisfactory.

Procedure.—In animals previously subjected to procedure 2 or 3 an intercostal incision is made an interspace below the previous incision, and the abdominal cavity opened widely. The œsophagus, previously transferred into the abdominal cavity by the elevation of the diaphragm, is resected between ligatures and the divided stumps cauterized. The distal stump is inverted into the stomach. The proximal stump is anastomosed with the fundus of the stomach. (See Figs. 6, 7, 8, 9, 10 from Miller and Andrus's paper.)§ It is quite easy to resect the lesser curvature of the stomach with the lower end of the œsophagus through this approach. The intercostal incision is closed.

Result.—The procedure technically is very easy. The approach to the cardiac end of the stomach is short and direct. The fundus of the stomach

‡ Johns Hopkins Hospital Bulletin, April, 1923, p. 109.

§ The authors wish to gratefully acknowledge the loan of the cuts for Figs. 6 to 10 by the Johns Hopkins Hospital Bulletin.

can easily be brought up to the level of the transplanted diaphragm without tension and without the division of any of its vessels. The placement of the posterior sutures between the œsophagus and fundus of the stomach naturally constitutes the most difficult part of the procedure (Fig. 11).

Six animals subjected to procedure 2 or 3, from fourteen to one hundred and twenty-five days previously, were again operated upon and an œsophagogastrostomy performed. One animal died upon the operating table just after the complete closure of the wound. Immediate autopsy showed a marked mediastinal emphysema perhaps sufficient to have embarrassed the heart. It is the only instance of the occurrence of this complication, and no doubt was due to insufficient care in our manipulations. The suture line was water-tight. In four animals the suture between œsophagus and stomach was perfectly satisfactory and there was no leakage from the suture line. These animals made perfect operative recoveries. One animal developed signs of peritonitis and died upon the seventh day. At autopsy leakage was found to have occurred from an imperfect suture line with the development of a purulent peritonitis.

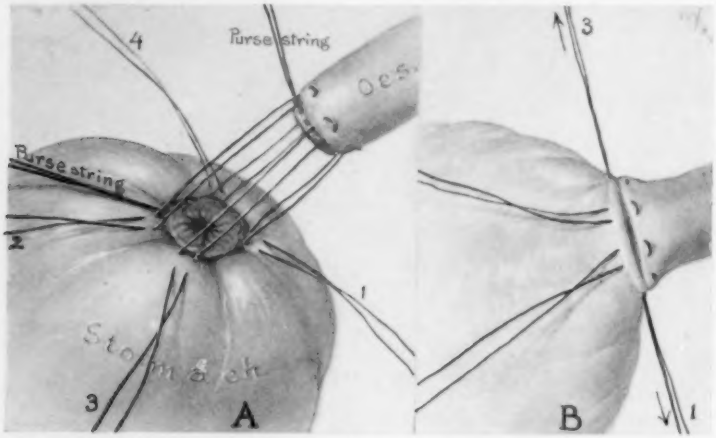

FIG. 9.—A. The four cardinal mattress stitches have been placed. B. The first layer is complete except for tying the two final sutures.

Of the four animals which recovered, one is living and in good health four months after operation. Two animals which vomited following the first stage (Procedure 2) stopped vomiting for six to eight days after the œsophagogastrostomy, but again began to vomit. At autopsy on the forty-fifth and forty-sixth days after the œsophagogastrostomy they presented, as previously noted, constrictions of the œsophagus at the new hiatus, but in addition had strictured openings at the site of anastomosis between œsophagus and stomach (Fig. 12). The remaining animal has recently been sacrificed, and at autopsy showed a perfect result.

Summary and Conclusions.—1. A two-stage operation for the resection within the abdomen of the lower end of the œsophagus and the cardiac end of the stomach is suggested. The first stage contemplates the transposition of the lower end of the œsophagus into the abdomen through the transplantation upward of the left half of the diaphragm. The second stage includes

the resection of the œsophagus and an œsophagogastrostomy. Whether the freeing of the œsophagus from its bed should be included in the first stage or left until the second stage, has not, in our own minds, been definitely determined. Our experience in one human case in which gangrene of the œsophagus, isolated during the first stage, occurred, suggests strongly that this step be left until the second stage. A gastrostomy preliminary to the first stage may be done without interfering with the technical steps of this procedure.

2. The transplantation upward of the left half of the diaphragm is a

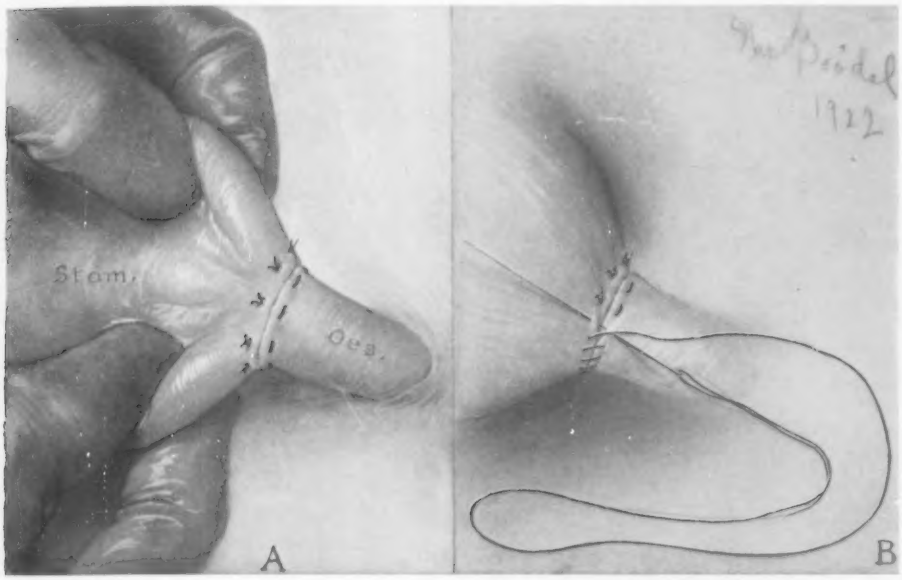

FIG. 10.—A. The first layer completed. B. Placing of the second and final suture layer.

simple and reasonably safe procedure. It has been done twenty-eight times in dogs and once in the human being. The occurrence of diaphragmatic hernia in two instances in dogs suggests that this is the complication most likely to occur. Sufficient care in the placement of the sutures should avoid this complication. Whether the phrenic nerve to the transplanted diaphragm be divided or not, does not, in our experience, make any difference in the result. In the one instance the diaphragm remains immobile, occupies a high position, and eventually, through atrophy, is converted into a fibrous sheet. In the other instance the transplanted diaphragm moves normally, but less in amplitude, and its musculature remains intact. It occurred to us that a mobile diaphragm by possible traction on the œsophagus might interfere with its function.

3. The formation of a new œsophageal hiatus which will not constrict the œsophagus, and at the same time not permit the development of diaphragmatic hernia, has proven to be the most difficult problem in connection with transplantation of the diaphragm. Our experience with procedure 2 suggests that the frequent occurrence of vomiting was due either to the constriction

of the œsophagus by the diaphragm or traction upon this structure during movements of the diaphragm. Procedure 3, in which neither factor is operative, would appear the better and will be given a further trial. In the two animals subjected to it vomiting did not occur, nor was there at autopsy any constriction of the œsophagus. It should be noted, however, that vomiting has frequently been observed in the experimental work of others in which constriction of, or traction upon, the œsophagus could not very well have occurred.

FIG. 11.—Autopsy specimen showing completed œsophago-gastrostomy with the diaphragm attached to the œsophagus some distance above the site of anastomosis.

4. Œsophagogastrostomy, performed within the abdomen through an intercostal incision, is technically not difficult. The operation can be performed without mobilization of the stomach. Resection of the cardia and lesser curvature of the stomach is quite feasible. The experience of previous investigators has shown that an end-to-end, lateral or end-to-side anastomosis between œsophagus and stomach when performed within the thorax is, in the dog, a reasonably safe procedure—so safe that it may be justifiably transferred to the human being. Our experience confirms this view. Performed within the abdomen where omentum and other structures are available to protect the suture line, it should be still safer.

The application of the above method in a case of carcinoma of the lower end of the œsophagus:

CASE REPORT.—F. G., aged sixty-one years, was admitted to the Cincinnati General Hospital, January 24, 1924, complaining of difficulty in swallowing, vomiting and pain in the pit of the stomach. Previous to November, 1923, he had excellent health. About Thanksgiving Day of that year he began to have pain in the lower lateral portion of his right chest. This came on suddenly, was continuous and was at first confined to an area

the size of a silver dollar. Later he had pain behind the lower end of his sternum, which was distinctly worse after taking food. He visited a physician, who after X-ray studies told him he had a constriction at the lower end of the œsophagus. About January 1, 1924, he began to have difficulty in swallowing solid or semisolid food, the ingestion of which was almost immediately followed by its regurgitation. Since that time he has lived on fluids which he can swallow satisfactorily. He has lost twenty pounds in weight. He entered the hospital for the relief of the obstructive symptoms.

Physical Examination.—A well-developed, although poorly nourished, rather cachectic-looking white man who evidently had lost considerable weight. The examination of the head, neck, thorax, abdomen and extremities showed nothing remarkable. There was no enlargement of the supraclavicular glands and no masses palpable in the abdomen. The Wassermann reaction was negative. Fluoroscopic studies of the œsophagus by Doctor Little showed an incomplete obstruction about two inches above the cardiac orifice of the stomach. Œsophagoscopic examination by Doctor Iglauer showed a nodular growth on the anterior wall of the lower portion of the œsophagus, 15 5 inches from the incisor teeth. It was diagnosed a carcinoma.

FIG. 12.—Specimen showing strictured opening at the site of anastomosis between œsophagus and stomach. The hypertrophy of the œsophageal wall is evident.

Operation. — (Doctor Heuer, February 14, 1924.) Exploration of carcinoma of the lower end of the œsophagus. Freeing of the lower 11 cm. of the œsophagus from its bed. Transplantation of the left half of the diaphragm, transferring the lower portion of the œsophagus, including the tumor, into the abdomen. Closure. Intratracheal anæsthesia (Doctor Andrus).

With the patient on his right side a long incision was made over the eighth rib and perhaps twelve inches of this rib resected. The pleura was opened widely and the ribs separated with a rib-spreader. The lung collapsed immediately and there were no adhesions. Examination immediately revealed a tumor of the œsophagus, the lower end of which began just above the œsophageal hiatus and extended 7½ cm. upward. The tumor was 5½ cm. in diameter. With our dog experiments in mind we began to free this tumor from the surrounding structures. In front, it was densely adherent to the pericardium, but separation from this structure was not especially difficult, although we had to stop periodically because of the irregularities in the heart caused by our manipulation. Lifting the tumor out of its posterior bed was a much more difficult matter. The tumor was found adherent to the wall of the aorta, and great care was exercised in separating it from this structure. In the course of the separation two large arteries, almost the size

of a radial, were found running from the artery directly into the region of the tumor. These had to be doubly ligated and divided. As a result of this procedure, the tumor mass assumed a bluish discoloration, but I thought that the circulation in the portion of the œsophagus which I had freed was perhaps adequate. After a considerable period of time we were able to free the entire tumor from the surrounding structures and to isolate the œsophagus above the upper limit of the tumor for about two inches. We therefore completely freed the œsophagus from its bed over a distance of about 11 cm. After getting this far, the patient's condition still being satisfactory, we incised the left half of the diaphragm close to its attachment to the thoracic wall and freed the œsophagus from the diaphragm at the hiatus. We then split the mobilized left diaphragm so as to form a new hiatus and resutured the split around the œsophagus. The diaphragm was then moved upward to a point two inches above the upper margin of the tumor and sutured to the thoracic wall around its entire hemicircumference. Two sutures were placed, fixing the diaphragm to the œsophageal wall at its transplanted point. At the completion of the procedure we had converted the lower 11 cm. of the œsophagus, including the tumor, into an abdominal viscus, and we proposed at a second stage to resect the tumor and make an anastomosis between the fundus of the stomach and the upper end of the divided œsophagus. The wound was closed with silk without drainage.

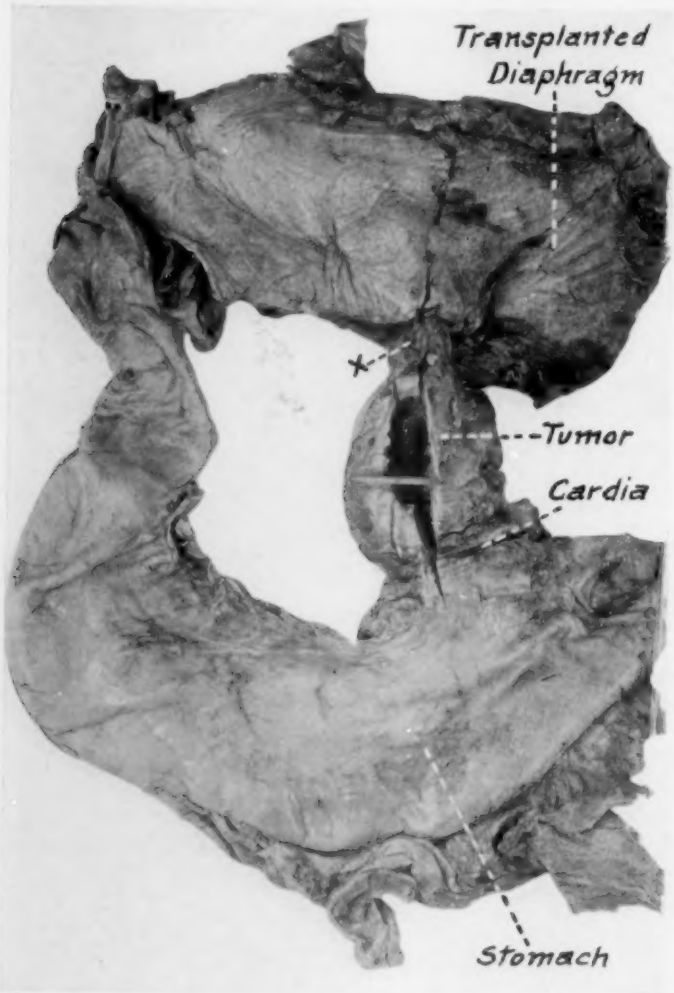

FIG. 13.—Human specimen of carcinoma of the lower end of the œsophagus, showing relations of stomach, cardia, tumor and transplanted diaphragm. The specimen has shrunken due to fixation and gives no idea of the segment of the œsophagus between the upper margin of the tumor and the diaphragm. This, at the completion of the first stage, was two inches in length—sufficient for a subsequent œsophago-gastrostomy. X indicates the site of perforation of the gangrenous œsophagus.

Pathology at the Operating Table.—The tumor, as noted, measured 7.5 cm. x 5.5 cm. in diameter. It was very hard on palpation and was adherent both to the pericardium in front and the aorta laterally. It could, however, be cleanly separated from these

structures. Palpation of the mediastinum after freeing the œsophagus failed to show any enlarged mediastinal glands. One or two small glands adherent to the tumor were freed with it and subsequently removed. Palpation of the stomach showed a chain of enlarged glands along the lesser curvature, which it was planned to remove at the second stage. Our examination, therefore, would indicate that this was an operable tumor.

Subsequent History.—The patient withstood the operation very satisfactorily. For forty-eight hours he was in good shape, then he developed fever, sank rapidly and died.

Autopsy.—Upon opening the thorax there was a small amount of purulent fluid in the left lower thorax. In the upper abdomen about the tumor mass there was also a small amount of purulent fluid. Examination of the œsophagus showed an area of gangrene involving the proximal half of the growth and extending upward upon the uninvolved œsophagus to a point 0.5 to 1.0 cm. above the new diaphragmatic hiatus. At one point on the right anterolateral wall a perforation had occurred in the gangrenous area, allowing leakage into both pleural and abdominal cavities.

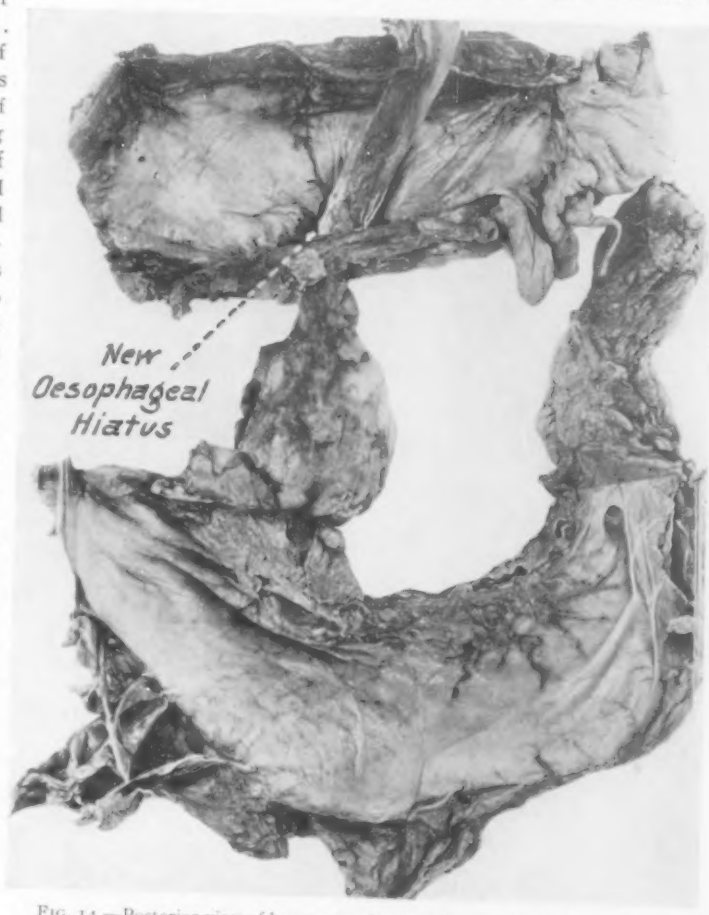

FIG. 14.—Posterior view of human specimen. The new hiatus is well seen.

The suture of the diaphragm to the thoracic wall was everywhere perfect. None of the sutures had pulled away. There was no diaphragmatic hernia. Death evidently was due to infection secondary to gangrene, with perforation of the œsophagus. The specimen showing the relations of stomach, cardia, tumor and transplanted diaphragm is shown in Figs. 13 and 14. A thorough examination of the body failed to show any involved glands other than those attached to the tumor and those along the lesser curvature of the stomach.

Pathological Diagnosis.—Carcinoma of the œsophagus, squamous cell.

Comments.—The first stage of the operation was, with the exception of freeing the tumor from the pericardium and aorta, quite as easy as in the dog. Our great mistake in this case was the freeing of the œsophagus in the first stage. During this procedure the ligature and division of two good-sized

vessels extending from the aorta to the œsophagus was followed by visible impairment in the circulation of the œsophagus; and we should either have deferred the mobilization of the œsophagus until the second stage or attempted to complete the entire operation at one sitting. Had we done the latter, however, it is doubtful that the patient would have survived it, and we would have obviated one of the advantages which the two-stage operation was intended to give, *i.e.*, the sealing off of the pleural cavity before the performance of œsophagogastrostomy. Our opinion at present is that the first stage should include only the transplantation upward of the diaphragm, and that the freeing of the œsophagus should be included with œsophagogastrostomy in the second stage.

THE SURGERY OF JAUNDICE*

By John B. Deaver, M.D.

of Philadelphia, Pa.

In the light of my surgical experience with jaundiced patients, it seems strange that jaundice should for so long have been considered purely a medical ailment and have been treated as such. It is only natural that in my work I find that the majority of cases of jaundice are not medical conditions, and that the pathology presented at operation rarely, if ever, lends itself to relief by other than mechanical surgical means. I therefore would suggest that jaundice be as much if not more stressed in the category of surgical than of medical diseases. The problem therefore is interesting alike to the surgeon and the internist, particularly from a diagnostic point of view. In fact, there are few other conditions in medicine and surgery in which the results of mutual coöperation between pathologists, physiologists, internists and surgeons have been of such value as in the study of jaundice. It is due to this joint study that, first of all, the classification of jaundice has been changed from a clinical entity to that of a symptom, and likewise that the definition of the disorder seems likely to undergo modification. Until quite recently icterus was defined as an extravasation of bile into the blood, indicating that the presence of bile in the blood was an abnormality. But the results of investigations, notably by Van den Bergh and his associates, seem to demonstrate that a certain percentage of bile is normally present in all blood sera and it is when that percentage is increased beyond a certain amount that it infiltrates the tissues and jaundice ensues. In fact, it is quite possible that not only the amount, but also the "quality" of the bile is of importance in tissue jaundice, whatever meaning future investigations may assign to that "quality."

If this theory proves correct, the definition would be changed to read: Icterus—a condition in which an excessive amount of bile of certain qualitative characteristics circulating in the blood causes a yellowish pigmentation of the skin and mucous membranes. Naunyn and his followers describe jaundice as a diseased condition, or rather a group of pathologic phenomena due to disturbed secretion of bile and consequent flooding of the system with bile.

Another result of diligent investigation into the true nature of jaundice is the discovery of the important fact that jaundice is not always limited to hepatic pathology, but that there exists a definite relationship between the spleen, and indeed the whole reticulo-endothelial system and the liver in the production of the blood changes that lead to the clinical picture of jaundice. But behind the clinical picture there lies not only the pathogenesis, but also the surgical significance of certain types of jaundice, and it is to the latter that I wish to confine my remarks at this time.

* Read before Inter-State Post Graduate Assembly of America, Tri-State Medical Association, October 28, 1924.

The surgeon is apt to recognize three pathogenic types of jaundice. The first is due to obstruction, the second to excess and perverted hæmolysis, and the third is a post-operative type due to infection and often to operative trauma; from a broad clinical point of view, a division into painful and painless jaundice also seems logical.

In passing it may be said that in painful jaundice the attacks of acute pain precede the appearance of jaundice. It is also worth while to call attention to the importance of the proper interpretation of the history of pain, for often such attacks of pain are the discomforts due to the accumulation of gas in the stomach and intestines, and close inquiry will show that the pain has never been severe enough to require an anodyne for relief. Painful jaundice is more amenable to permanent relief by operation than painless jaundice, so that from the standpoint of the patient's future, it is not so serious a condition as the painless type.

The most common types of jaundice are the jaundice of gall-stone obstruction, of carcinoma of the head of the pancreas, and of cholangitis, the two latter of the painless type. The jaundice (painless) of the splenomegalies is not so frequent as the ones just mentioned. A type of painless jaundice the surgeon too often sees is that due to injury of the common or of the hepatic duct following operation.

So-called catarrhal (painless) jaundice, having its origin in a gastro-duodenal irritation, is the result of a mild cholangitis or liver cell damage which usually subsides in a short time if the mild proper diet is observed. In the majority of cases of chronic catarrhal jaundice that have not yielded to the recognized non-surgical treatment, I have found a mild pancreatitis and cholangitis, which I believe was caused by the infection having extended from the papilla of Vater into the pancreatic and common bile ducts. At operation in this type of jaundice the pancreas will be found to be increased in density and enlarged throughout its entirety, differing in this respect from the cases of chronic pancreatitis caused by lymph-borne infection where the inflammation usually involves and is limited to the head of the pancreas. In the patient with catarrhal jaundice and a decidedly pronounced cholangitis that does not yield promptly to medication, surgical, and not so-called medical, bile drainage should be instituted.

The rarer forms of jaundice due to carcinoma of the bile ducts, diverticulum of the common duct, nervous shock, acute hæmolysis, retro-peritoneal and other infections are of interest but not so important practically as are the other forms.

Jaundice following infection elsewhere than in the upper abdomen is not often seen, but it does occur. I have in mind two cases in particular.

In one, a superficial infection of the leg immediately above the ankle, in spreading caused abscess formation high up on the leg and the fleshy portion of the thigh with enlargement of the lower chain of inguinal lymphatic glands of the corresponding side, as revealed by deep palpation below Poupart's ligament. This was followed by a retro-peritoneal purulent collection and jaundice. A provisional diagnosis of appendicitis was

made and at operation the retro-peritoneal collection was found to open into the peritoneal cavity; a large amount of pus was evacuated. The appendix was normal.

In the second case, a recent one, jaundice with acute hæmolysis occurred in a young woman suffering from infection following self-induced abortion. Autopsy showed pelvic infection, a perforated uterus; the spleen weighed 240 gms., was firm with the notch prominent, and smooth surface. It cut readily and the cut surface, firm, dry and dark red, was the seat of an acute splenic tumor in an early stage.

Sections: 1. Gangrenous endometritis. Acute suppurative metritis.
2. Acute hyperplastic (infectious) splenic tumor.
3. Lungs.—Passive congestion and œdema.
4. As No. 1.
5. Liver.—Jaundice, marked cloudy swelling, acute interstitial hepatitis, formation of bile thrombi.
6. Same as No. 5.
7. Kidney.—Acute glomerulo-nephritis, with necrosis of tubular epithelium and hyaline thrombosis of capillaries.
8. Kidney.—Same as No. 7.
9. Lung.—As No. 3.
10. As No. 1.

Complete blood count on day of admission, July 26, 1924:

Hemo.	75
R. B. C.	4,450,000
W. B. C.	34,200
Poly. Neutr.	91
Lymph.	6
L. Mono.	2
Trans.	1
Eosin.	0

Coagulation time 3¾ minutes.

Complete blood counts on—

	July 27	July 28	July 29 (day of death)
Hemo.	65	40	25
R. B. C.	2,130,000	1,650,000	1,920,000
W. B. C.	32,200	19,000	5,800
Poly. Neutr.	92	90	62
Lymph.	4	6	32
L. Mono.	1	2	4
Trans.	2	1	2
Eosin.	1	1	0

Jaundice caused by poisons, nervousness, fright, grief and so forth, is not pertinent to our subject.

Obstructive jaundice is the most common type with which the surgeon has to deal. It has its origin in the liver and is due to gradual or sudden, partial or complete, temporary or permanent obstruction, either within or without the ducts, to the flow of bile. Complete or partial obstruction may result from tumor formation at the papilla of Vater, in the common duct, in the head of the pancreas; or it may be due to stone formation and to stricture of the papilla of Vater, or stricture of the common or of the hepatic duct. While it is possible for small stones to pass through the papilla of Vater, larger ones will lodge at this point, with increased obstruction as the result of inflammation caused by their presence.

Sufficient stress is not being placed upon the contracted papilla of Vater as a cause of at least temporary obstruction of the common duct and jaundice. I have met with this condition often enough when with the common duct opened nothing but the tiniest metal probe properly shaped, followed by rapid dilatation with a series of larger probes, could pass through the papilla, to convince me that this is one of the many pathologic phenomena of gall-stone disease. Assuming that in the average patient bile can be aspirated by the duodenal tube, this condition would preclude any such possibility.

The contraction I refer to is not a reflex spasm of the muscle of Oddi, but a stricture in the formative stage. If resolution does not occur or the stricture is not dilated, it leads to permanent obstruction of the papilla. When the pancreas extends on to the portion of the duodenal wall including the terminal portion of the common duct, as is occasionally the case, inflammation of the same may cause constriction of the papilla of Vater.

Obstruction of the common duct may also result from outside compression, as from neoplasms, either primary or metastatic. It is a well-known fact that the numerous lymphatics along the course of the hepatic vessels are favorite sites of carcinomatous infiltration.

Complete obstruction may also result from compression due to syphilitic processes, as well as from the scars of duodenal and gastric ulcers, also from carcinoma of the gastro-hepatic omentum at the site of the transverse fissure of the liver. Obstructive jaundice is also sometimes the result of conditions in the smaller ducts and the tiniest ducts within the liver itself, due to infectious cholangitis or to the presence of stone in the hepatic duct. And then there is the most common type of obstruction, which usually is partial and intermittent, associated with stone or stones in the common duct with ball-valve action. These types of jaundice can only be relieved by operation.

Hæmolytic jaundice was formerly considered as purely of hæmatogenous origin. That is to say, the phenomena of increased fragility of the red cells with subsequent disintegration and formation of bile pigment, to which the jaundice is due, takes place independent of the bile-forming function of the liver. Here again investigation has modified our conception of the process. A host of investigators have established a close relationship between hæmolytic jaundice and the behavior of the liver cells. As a result of diminished resistance (possibly one of the basic causes of hæmolytic jaundice) the red blood-cells are destroyed by the spleen in large numbers and the liver is flooded with pigment which increases the viscosity of the bile and produces inspissated plugs in the small biliary ducts. Since the pressure of the bile itself does not suffice to send it onward, it accumulates and is forced into the lymphatic system and thence into the blood stream with icterus as a result. In fact, there is the same thrombosis of the bile capillaries as in obstructive jaundice. The term hæmolytic jaundice is usually associated in our minds with disease of the spleen and to the surgical mind it generally suggests the association of so-called splenic anæmia, pernicious anæmia, or Banti's

disease. It must be borne in mind, however, that these original splenic conditions are more often than not related to disease of the liver and the gall-bladder, particularly cholelithiasis. This relationship is explained by William J. Mayo somewhat as follows: The predisposition to the formation of gall-stones is due to the viscosity of the blood caused by the flooding of the liver with blood pigment set free by the destruction of numerous red blood-cells in the spleen. This may lead to cholangitis and finally to cirrhosis of the liver. The clinical picture of hæmolytic jaundice, as you are aware, consists of splenomegaly, acholuric jaundice and more or less marked anæmia. The condition can be cured only by removal of the spleen, which cannot be done too early.

In addition to the cholangitis and peri-cholangitis associated with chronic pancreatitis, either of the head or of the entire pancreas, there will occasionally be present a chronic splenitis with jaundice from which relief is only obtained by removal of the spleen and establishing bile drainage, by either a cholecystostomy or a cholecysto-duodenostomy or a choledochostomy.

The chronic jaundice of biliary cirrhosis can be relieved only by a drainage operation, but it must be done early if any good is to be accomplished. William J. Mayo has made this clear in a recent description of biliary cirrhosis, which he divides into three types. He states, and rightly too, that biliary cirrhosis is most often the secondary result of infectious and obstructive processes having their origin in the gall-bladder or the common duct, usually from gall-stone disease. Obstruction of the small bile ducts leads to early and continuous jaundice. The most common cause of obstruction is stone in the common duct and enlargement of the head of the pancreas. In this type of biliary cirrhosis the splenic enlargement is not marked, but the liver is definitely enlarged and is dark in color, soft, bleeding easily on the slightest injury. Removal of the spleen is not indicated, but the infection must be removed, which means removal of gall-stones or of the infected gall-bladder and perhaps in addition also drainage of the common bile duct. This type of cirrhosis is very promising if operated early.

In the second type, less common than the first type, there is no demonstrable infection or obstruction in the bile ducts. The ducts are much thickened; jaundice is chronic and splenic enlargement is much more pronounced than in the first type. The liver is also enlarged and rather firm. In these cases bile drainage and sometimes removal of the spleen is the indicated procedure. When the gall-bladder is in comparatively good shape with the cystic duct distended with bile, but patulous, cholecysto-duodenostomy should be considered. In the third type of cirrhosis described by Mayo as the splenic type, the disease is very chronic and little can be done. Removal of the spleen may sometimes be of value. Although the relationship of these various types of cirrhosis of the liver to the spleen and hæmolytic jaundice is still obscure, Mayo's observations, nevertheless, are of great practical value.

Post-operative jaundice constitutes perhaps the most difficult type for the surgeon to treat. While to some extent it may be a reflection upon his technic, the entire blame does not always fall on him, for oftentimes it is

unavoidable owing to the extent and degree of pathology present which I have no doubt is frequently due to belated operation.

What are the conditions that lead to this post-operative phenomenon? Most often injury to the common bile duct and occasionally the hepatic duct, and stirring up infection by the traumatism of the operation. For example, after cholecystectomy or cholecystostomy, more likely the former, where the patient was not previously jaundiced, jaundice occasionally appears two or three days after operation and, in my experience usually clears up in a comparatively short time. It is evidently cholangitic due to disturbed liver function the result of manipulation during operation. To the inexperienced observer the occurrence of such jaundice may give considerable unnecessary anxiety and naturally bring up the question of possible injury to the common or to the hepatic duct. Post-operative jaundice occurring some time after operation resembles carcinoma of the head of the pancreas in that it gradually increases in intensity and is accompanied by itching, weakness, loss of weight, loss of appetite and nausea, the last, however, not so conspicuously prominent as in the jaundice of carcinoma. While the history of a previous operation suggests chronic pancreatitis, it is difficult, and I might say almost impossible to differentiate between chronic pancreatitis and carcinoma of the head of the pancreas except by operation. A distinguishing feature of carcinoma may be general and rapid decline in health, and marked loss of weight. The jaundice is greenish in tint and unvarying and preceded by nausea, loss of appetite and increasing weakness. While in chronic pancreatitis there is loss of weight, the jaundice is mild, increasing in intensity and accompanied by itching, and the appetite remains good.

In calculous obstruction of the common duct the jaundice is intermittent and varying in intensity, the urine and stools showing the same variations; chills, sweats, fever and colicky pain usually precede the jaundice.

Sudden onset of clay-colored stools, and jaundice accompanied by colicky pain may be taken to indicate obstruction within the bile ducts.

On the other hand, jaundice in a young person, preceded by symptoms of gastric catarrh, is probably a catarrhal jaundice. In this and certain types of non-obstructive jaundice the stools are not clay-colored.

I have digressed somewhat from the subject of post-operative jaundice to give these few guiding points in the differential diagnosis of some kinds of obstructive surgical jaundice which may be of value when properly correlated with the history, physical examination and laboratory findings.

In the jaundice of cholangitis not due to calculous obstruction of the common duct, but to choledochitis with thickening of the walls of the duct, anastomosis of the gall-bladder to the duodenum, where the cystic duct is patulous and the gall-bladder practically normal, is perhaps the best operative procedure. Where the gall-bladder is present and intact and the lesion is a non-traumatic stricture of the common duct, this operation will terminate the jaundice, and still it is not the operation of choice. The better procedure is dilatation of the stricture by opening the duct and the introduc-

tion of a T-tube. Some years ago I operated upon a colleague who was thought to have carcinoma of the head of the pancreas, and in whom was found a stricture of the hepatic duct. I dilated the stricture, as described, and introduced a T-tube, which was worn for several weeks. The doctor continues well now ten years since the operation.

The exposure of the field of operation in these secondary cases requires care, especially in the presence of extensive and well-organized adhesions, which often present a conglomerate mass, entangling alliances, as it were, often difficult to disentangle. It has been my experience that in the cases where the gall-bladder has been removed, the adhesions are more troublesome to deal with than when a cholecystostomy has been done. A common finding is the great omentum, the hepatic flexure of the colon, the duodenum and the pylorus adherent to each other and to the under surface of the liver corresponding to the gall-bladder bed. When the gall-bladder has been drained the adhesions are not so deeply placed. In the former type of cases I often have had to spend more time in freeing adhesions and adherent viscera than in the operative technic upon the duct.

What are the usual operative findings in the case of bile duct injury? The free border of the gastro-hepatic (lesser) omentum presents a more or less cicatrized and thinned out appearance. The foramen of Winslow is occluded. The portal vein is more than usually prominent. Delicate dissection fails, except in a few instances, to find the lower end of the common duct. The lower end of the duct can sometimes be identified by opening the duodenum, locating the papilla of Vater and passing a probe through it into the lower portion of the common duct, but I do not recommend this procedure. Careful and painstaking dissection will expose the upper end of the duct, often in a mass of cicatricial tissue or in the shape of a bulbous end; the latter being identified by hypodermic aspiration. Where only cicatricial tissue at the site of or close to the transverse fissure of the liver is seen, a carefully directed incision through this inflammatory tissue at its thickest and densest point will yield a free discharge of bile, and thus the duct is identified. The repair of the duct in the conditions described is one of the most trying operations, calling for anatomic knowledge, patience and determination, along with the gentlest manipulation. But the results of operation have given me much satisfaction and the patients great comfort. The successful issue of these cases depends primarily upon the proper exposure of the anatomy involved, for to operate blindly is to operate unsuccessfully.

When the ends of the duct cannot be brought in apposition and sutured, I consider it best to anastomose the proximal end with the duodenum either with or without the aid of an in-lying catheter. But when the proximal end of the duct is long enough to anastomose without the aid of a catheter, this should be done. (Fig. 3.) Hugh Williams, and also Lahey, of Boston, have recently reported successful transplantation of a common duct fistula into the duodenum, basing the procedure on the established fact that the pressure of the bile being sufficient to keep an external fistula open, there seems to be no

reason why the same pressure should not act similarly on an internal fistula, that is, keep it permanently open. Lahey also suggests that in case this simple operation did not prove successful one or the other of the more tried out, but more complicated ones, can later be done. I have mentioned these suggestions because they differ somewhat from the methods in vogue by other surgeons. Almost every active surgeon has a method of his own for reconstructing the common bile duct injured at operation. It is my own intention to describe these, but rather to show the different procedures which I, personally, have found useful.

The post-operative dangers to the jaundiced patient are hepatic insuffi-

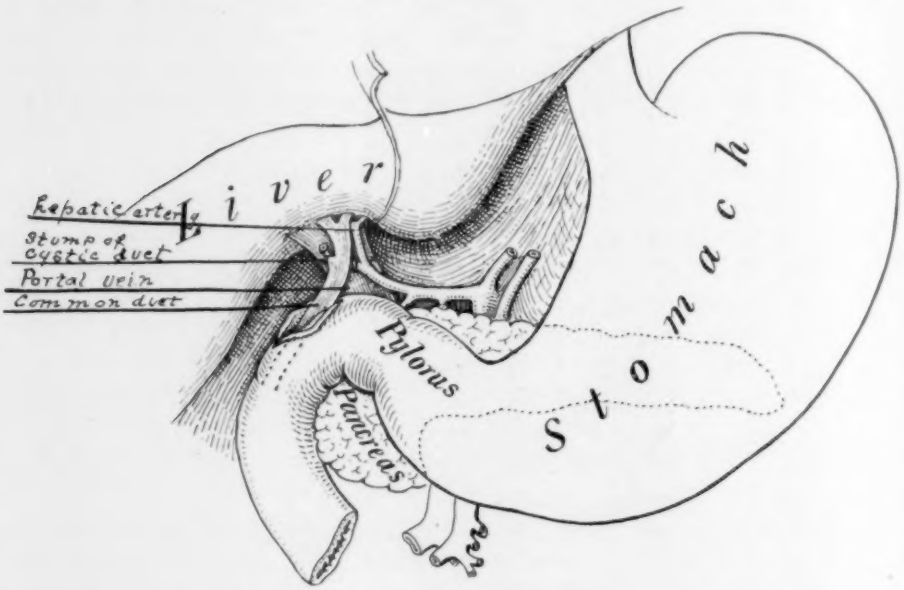

FIG. 1.

ciency and bleeding. But the latter is rarely seen since we are giving chloride of calcium intravenously before operation. But hepatic insufficiency is to be reckoned with and in my experience when decidedly pronounced proves fatal in spite of all measures, such as plenty of fluid consisting of water by mouth, saline and glucose solution by enteroclysis or intravenously. The relationship between hepatic and renal insufficiency is so close that these patients practically die of uræmia. The old saying, an ounce of prevention is worth a pound of cure, here means careful pre-operative examination and pre-operative treatment. Operation, except in some emergency cases, where the urine contains acetone and diacetic acid, should not be done until the urine is negative to these. It also means early recognition of a surgical condition. Faith in medical drainage and negative X-ray findings are responsible in part for delayed operation, and to no less a degree for failure to make an early diagnosis. The determination of liver function by phenoltetrachlorphthalein has been somewhat unsatisfactory in our hands, using both the duodenal tube and

the blood methods, inasmuch as when the liver function was decidedly low, it could be determined by other means, as for instance, the symptoms. On the other hand, we have had disappointing complications which we feel were due in large measure to hepatic breakdown when the results of this test indicated that we were safe. Irrespective of the analysis employed, and the one determining the dye in the blood seems the only rational way, we believe, that the functions of the liver are so manifold, that any one method, *i.e.*, with dyes, etc., is theoretically liable to large errors. In addition, the large margin of

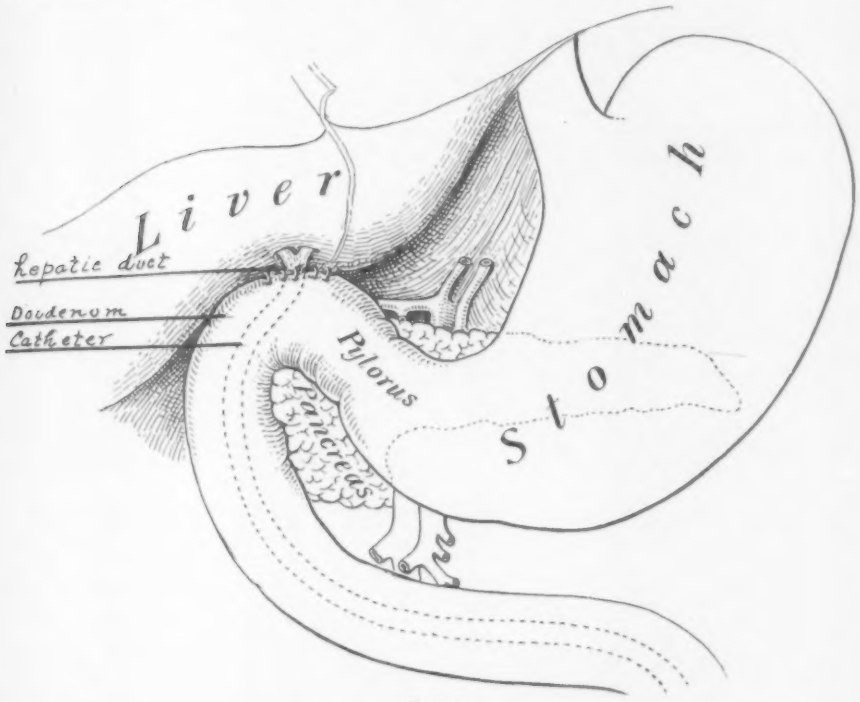

FIG. 2.

safety provided in the liver is a factor making finer distinctions quite difficult to attain. I am convinced beyond a doubt that those of my colleagues who have seen the greatest number of living autopsies in jaundiced patients have the best grasp of the diagnostic situation. Fortunately, or unfortunately if you will, these patients are not as a rule seen by the surgeon until they have been treated for a period long enough to have missed the best chance which early surgery could have given them. The nearer the patient is to being well when operated the surer he is of getting well.

Next to early diagnosis the essentials of success are preparatory treatment in the shape of careful examination, which must include the study of the circulation, the blood sugar, the urine, urinary output, cardiac function and careful scrutiny for focal infections; finally, the patients should be divided into the lean and the fat, and especial treatment accorded the latter.

Obese patients require particular attention in the way of diet and reducing

exercises. I do not operate on a fat subject in the presence of high blood sugar or when the urine contains acetone and diacetic acid without suitable

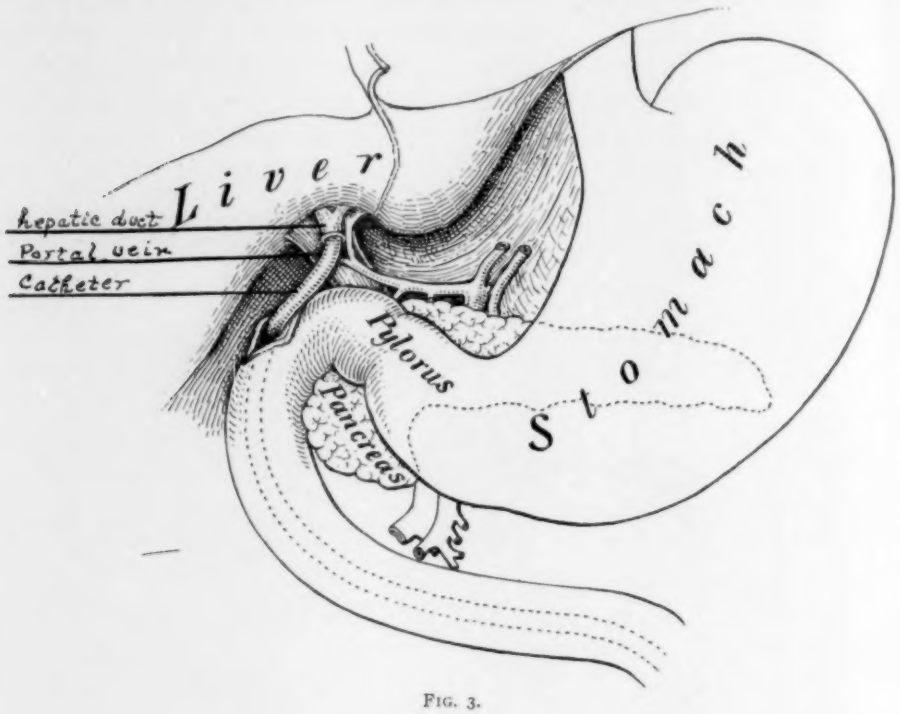

FIG. 3.

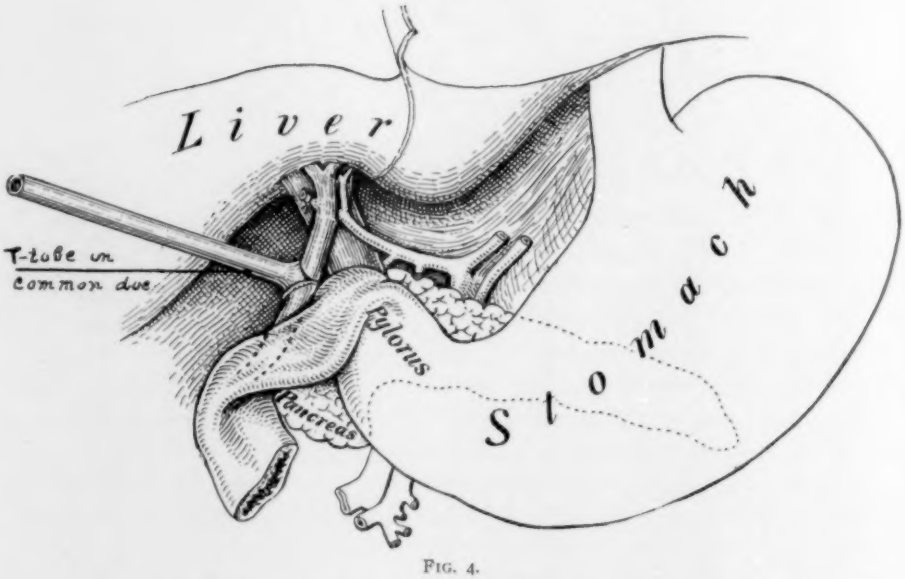

FIG. 4.

pre-operative treatment. Insulin, given with judgment, even in the absence of sugar in the urine, is in place. There is a relationship between high blood

sugar and the glycogenic function of the liver, and the high temperature in the hepatic insufficiency following operation is also significant.

Other factors in causing hepatic insufficiency following operation are too much anæsthetization and the amount of traumatism to which the liver in particular has been subjected. In the presence of much pathology, and especially if of long standing, I care not how skilful and gentle the surgeon may be, a certain amount of operative traumatism is unavoidable. When the structures involved in the dissection are welded together, as it were, the surgeon may have to resort to the hatchet the crowbar and the trowel. I want to impress this upon our medical colleagues. Dillydalling, pussyfooting, sidestepping, sparring for wind in these cases is too often disastrous.

Where the common or hepatic duct has been cut completely across, which is rare, and this is recognized at the original operation, it goes without saying, repair of the injury should immediately be made. This will consist simply of suture, care being taken to obtain edge-to-edge apposition. This can as a rule be accomplished without the aid of a rubber tube, but if it cannot be done I advise using a T-tube in preference to a straight rubber tube, first suturing the posterior walls of the ends of the duct, then introducing the tube, when the suture of the anterior wall is made. The advantage of the T-tube is the immediate and prolonged bile drainage obtained, so important in the treatment of cholangitis which is so often present (Fig. 5.)

FIG. 5.

T-tube—French make. T-tube—American type.

The more common accident is perhaps partial division of the duct; such an opening can be closed by suture with little or no trouble.

In the secondary operation when the two ends of the injured duct can be identified and freed and the gap between the ends is not so large as to preclude their apposition, the ends may be sutured with or without the presence of an in-lying rubber tube. Were it possible to have a decalcified bone tube of the proper size, this might be more ideal. When the distal end of the duct cannot be identified so that there is no chance of opposing the two ends, some other procedure, depending upon the extent of the injury, is the method of choice. (Figs. 2, 3 and 4.)

The length of the time between the introduction of the catheter and its passage varies in different cases from as early as four weeks to several months. Occasionally the catheter becomes blocked, but usually this is corrected by the bile flowing around the catheter. Personally, I have never had to remove the catheter, yet I can see this might have to be done. I have used the T-tube in innumerable cases of gall-stone disease and have rarely had any trouble in the shape of blocking of the intra-ductal part of the tube. Here of course we have the advantage of being able to flush the tube. As I have already reported on previous occasions, I had one patient who wore a T-tube for four years without causing any trouble.

The methods of reconstruction of the duct practiced in the past are obsolete. The chief among these consists of rebuilding the duct over an in-lying straight rubber tube, making use of the omentum for reinforcement. Unfortunately when the common duct has been reconstructed in this manner and covered by omental grafts or by means of a flap of gastric or intestinal wall, the patients as a rule do not remain well, and sooner or later develop a stricture with recurrence of jaundice calling for further operation. After these operations drainage is necessary, using rubber dam or rubber tubing, which should be removed not later than the second or third day.

In conclusion I would add that the operative treatment of jaundice of course depends upon its cause. It may consist of gall-bladder drainage, either externally or through the duodenum; removal of the gall-bladder; drainage of the common duct; anastomosis of the common duct to the duodenum or removal of the spleen.

Cholecysto-gastrostomy I never perform except when the duodenum cannot be mobilized. I know the latter operation is a great favorite, but I believe cholecysto-duodenostomy is more in keeping with nature's manner of disposing of the bile by emptying it into the duodenum.

From what I have said, assuming it is true that pathology of the living does not lie, the medical man can take home with him this warning: in a case of jaundice the surgeon can never be called too early, but he can be called too late.

JAUNDICE

ITS PATHOLOGICAL PHYSIOLOGY

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In a discussion of the pathological physiology of jaundice two main types should be differentiated: Obstructive jaundice due to mechanical causes such as stones in the ducts, and hæmolytic jaundice which is correlated with hæmolysis as the name implies, of course, pathological in amount, and possibly in quality also. We might clarify this division and also plunge directly into our problem, by saying that the first type, namely, obstructive, is due to causes practically all of which are in the liver and its ducts, and that the second type, namely, the hæmolytic, is due to causes in which the exact part played by the liver is problematic and possibly secondary. In either of these types, it is the general icterus which discolors all the tissues and fluids with few exceptions, that is the topic of our discussion. The first and most obvious question which arises is, "how does bile reach the general circulation so that it may be carried all over the body, and are the paths different in obstructive and in hæmolytic jaundice?" The second question is "is the jaundice due to a different bile in the obstructive and hæmolytic varieties?"

It would seem at first thought that the routes by which bile reaches the circulation are different in the two types, but opinions are still divided, and before we can proceed to their discussion, it is necessary to rehearse a few of the anatomical relations. There are said to be tiny vacuoles within the liver cells themselves, in which the bile is formed by the protoplasm of the cells. The bile is then said to escape through most minute intracellular secretory channels. Then by some it is said that the interior of the liver cells can be injected from within the blood-vessels, that is, that there is no definite wall between the lumina of the blood capillaries and the inside of the liver cells. Thus there would be a direct communication between the bile canaliculi and the blood capillaries. Under normal circumstances these pathways bring nutriment from the blood into the cells while the minute bile channels serve as a means of exit into the larger ducts. In obstruction to the outflow of bile, however, whether by gross mechanical means or otherwise, these intracellular bile canaliculi are filled with brown and yellowish-green masses, so that, at least under such pathological conditions, there is a possibility of direct entrance of bile from liver cells into the blood. This idea, however, has not received verification, indeed has been subject to sharp criticism, not so much on the basis of actual findings, as on the deductions of the physiology therefrom. The chief objection is raised by those who believe that bile and blood capillaries are always separated either by cells or at least by protoplasm. This means that

in order for bile to enter the blood directly from the liver cells, it is necessary that some sort of tearing take place. Now the blood capillaries are enveloped by a system of fibres with interstices between, but there are no lymph capillaries with distinctive walls such as are found elsewhere in the ordinary perivascular lymphatic system. During obstruction to the outflow of bile, the tiny intracellular passage-ways may rupture, and with them the liver cells, so that bile will pass into the spaces in the fibrous tissue network surrounding the blood capillaries. From there it will pass into the lymph stream and enter the blood by way of the thoracic duct. But, on the other hand, certain investigators have found that icterus develops when the common duct is obstructed, even when the thoracic duct is ligated. The entrance of bile into the blood must therefore have been direct, and the conclusion follows that the direct blood route is chosen, at least under the circumstances of obstruction to the thoracic duct. Briefly then, in the anatomy of the liver, the structure of the beginnings of the bile duct system, the structure of the blood and lymph capillaries and what is very important, the triple inter-relation of these systems are not understood. This lack of knowledge naturally precludes our saying whether the bile in obstruction enters the blood directly or through the lymphatics, or whether the liver cells, lymphatic or blood endothelium must first be damaged before jaundice can occur. At all events, whichever is the truth of the matter, in obstruction to the outflow of bile, important pathological masses are found—the so-called bile thrombi. These are clumps of debris which close the smaller to smallest bile passages like corks and thus further the stasis of bile and the tearing of liver cells and perhaps also of lymph and blood-vessel endothelium. Microscopically, they appear as masses of brown or yellow pigments often in geometrical shapes, which give the appearance of being in a preformed space which is distended. In fact, the finding of these clumps of bile pigment is the way to diagnose jaundice in a microscopic preparation of liver tissue. Their mode of formation is still under dispute. They may be composed merely of thickened bile; they may be coagulated bile, that is, bile mixed with fibrin, but important observers believe they only occur as a result of injury to liver cells, that is, when there is a qualitative change in the bile secreted. A very important point about them, and one which must be remembered constantly is that they occur without such gross mechanical factors as occlusion of the large bile ducts, and are seen for example, in the jaundice following puerperal sepsis and similar toxic-infectious conditions. In gross obstruction, therefore, as from a stone in the common duct or, in the terms used before, in the jaundice in which the liver is the chief organ involved we do not as yet know the answer of the first question, *i.e.*, whether bile enters the blood directly or *via* the lymph channels. Now this question seems and probably is of little importance in obstructive jaundice, it is only because of its importance in hæmolytic jaundice that we have insisted on its discussion. After all, obstructive jaundice is fairly easy to understand since causes such as stones or tumors can always be

found; it is the study of the jaundice occurring in hæmolysis which presents the difficulties from all angles.

Before discussing the possible mechanisms of hæmolytic jaundice, it may be well to remind ourselves of several points in the chemistry. The bile as manufactured by the liver and discharged through the common duct contains many ingredients, but the most important are the bile salts and the pigments. Bilirubin is the chief pigment, and the sodium glycocholates and taurocholates are the chief salts. Bilirubin is an isomer of hæmatoidin. When red blood-cells are destroyed, let us say, in the spleen, their hæmoglobin is decomposed into hæmosiderin, which is the iron containing, granular, insoluble portion, and hæmatoidin, the soluble moiety, which is changed to bilirubin by a rearrangement of the atoms in its molecule. The most important fact concerning this chemical change is that it can be accomplished in many parts of the body such as the liver, spleen and endothelial containing structures in other situations. In brief, hæmatoidin derived from the hæmoglobin of destroyed red blood-cells can be changed into bilirubin, the bile pigment, in any part of that entire group of organs which constitutes the so-called reticulo-endothelial system, which means in the liver, spleen, bone marrow, lymph-nodes, the endothelium of blood and lymph vessels and of serous cavities. Bile salts, on the other hand as far as we know are manufactured in one situation and in one situation alone and that is in the liver. We will return to these questions presently.

When we speak of hæmolytic jaundice, we necessarily involve the spleen, the bone marrow, the red blood-cells themselves and various poisons destroying red blood corpuscles. Among the diseases we think of pernicious anemia, splenic anemia, sepsis and traumata allowing blood to accumulate in serous cavities. Jaundice occurs in all of these conditions as well as in others which will occur to you. How is the jaundice brought about? The simplest explanation is that the red blood-cells are destroyed, their debris is picked up by endothelial cells in the spleen and other situations, the dissolved hæmoglobin is changed to hæmatoidin and hæmosiderin, and the hæmatoidin into bilirubin, thus discoloring the tissues directly. In other words, this simplest theory would indicate that the liver plays practically no part except in so far as its Kupfer's cells are merely part of the reticulo-endothelial system and nothing more. But does the liver take part in hæmolytic jaundice? Experiments such as the following seem to complicate this theory and indicate that the liver is involved.

It is known that jaundice follows the inhalation of arsine, which is a typical hæmolytic poison, but several investigators have shown that icterus does not follow the inhalation of this poisonous gas when the liver is removed, that is, it did not occur in geese and ducks whose livers lend themselves to removal. In other words, this means, at least in these animals, that there can be no icterus without participation by the liver. Certain it is that the inhalation of arsine produce hæmolysis, but the icterus would seem to be due to something more than mere change of the destroyed red blood-cells into bilirubin within the

reticulo-endothelial system. Icterus likewise often follows hemorrhages into the serous cavities, under the skin, of which fact the slight icterus lasting but a few days sometimes following ruptured ectopic pregnancy is an example.

The liver is probably involved even in such conditions, and to explain it, one group of investigators has introduced the conception of a change in the quality of the bile due to the arrival in the liver of excess of bile pigments from other situations. In other words, when there is excessive hæmolysis from some cause or another, there is an increased amount of pigment brought to the liver *via* the blood. As a result, a thicker, more viscid, pleiochromic as it is called, bile is secreted, which by coagulation or inspissation will block the smaller ducts with thrombi. This can be called a hæmatogenous-hepatogenous jaundice or a pleiochromic jaundice, but in the last analysis, obstruction to the ducts is the ultimate cause, so it is in reality an obstructive jaundice.

But can a pleiochromy alone, that is, merely a bile too thick or too rich in pigments, cause general icterus? Many investigators believe there must be something else added, and thus there arose an idea concerning itself with the secretory activities of the liver. It may be called the parapedesis theory. According to this, the liver cells secrete physiologically in two directions, sugar, urea, etc., toward the blood, and bile in the opposite direction toward the bile channels. It seems logical to believe that disturbances such as overloading of the cells from excessive bile pigment, or conditions such as cloudy swelling, fatty degeneration from infectious or toxic processes, may change the direction and quantity of these secretions even without mechanical hindrance to the bile flow. Thus bile might be secreted toward the blood capillaries and icterus develop. The objection to this theory is that so little is known of the forces at work sending the secretions in their proper directions. Certain it is that bile thrombi and capillary ruptures can be found in these cases, and thus mechanical causes easily demonstrable should not be forgotten for more highly theoretical ideas. We have already mentioned that these thrombi are present in gross obstruction, and since they have been found also in just such cases of hæmolytic jaundice in which the more or less theoretical pleiochromy may or may not have been present, there is more than one investigator who says that bile thrombi are the general cause of all forms of icterus. Indeed, Naunyn says that there can be no icterus caused purely by excess of bile pigment formation, that is by hæmolysis, and that the liver must participate in every jaundice. He, himself, has introduced the conception of a capillary cholangitis, which means that even in excessive hæmolysis, there is inflammation, infectious or not, of the finer bile canaliculi. So that all of these considerations class hæmolytic jaundice merely as an obstructive jaundice of a certain variety.

In icterus neonatorum also, the sum of the evidence points to a hæmatohepatogenous origin; in Weil's disease or infectious jaundice, there are extreme degrees of hæmolysis, but the degenerative involvement of the liver is so manifest, that here, also, the jaundice must be considered a hæmatohepatogenous process.

There yet remains one point which must be disposed of as well as we are able at present, and that concerns the quantitative behavior of the bile pigments and the bile salts. We have already said that bile pigments may be formed in many parts of the body and that bile salts are formed in only one situation, and that is in the liver. It is the bile pigments which produce the discoloration of the skin, mucous membranes, sclera, the internal organs, etc. The bile salts have nothing to do with this pigmentation, and hence do not lend themselves to qualitative recognition by a glance at the patient. It would seem that this problem of involvement of the liver in hæmolytic jaundice could be disposed of by analyzing the blood for its content of both pigments and salts. If pigments are present in excess but no salts, and there is jaundice, it would indicate that the liver is not involved. If both pigments and salts are present, the conclusion would naturally follow that the liver participates. This seemingly simple idea is quite attractive, but it has never been proved either negatively or positively, for a very good reason, and that is that the methods in use at the present time for the quantitative estimation of both these bile constituents leave much to be desired. Our present methods require the attention of quite expert chemists, and even in their hands the final results are far from being as quantitatively correct as is necessary. Consequently all figures for these analyses are looked upon with some suspicion. We can set ourselves the task then of interesting expert chemists in discovering methods of analysis so that we may apply them and perhaps add a new diagnostic procedure of the utmost importance in many cases. It is unnecessary to more than recall the difficulties of diagnosis which are so frequently presented in many clinical cases of jaundice, difficulties not only in distinguishing the various causes of obstruction such as are due to stone in the common duct and carcinoma of the head of the pancreas, but actually, strange as it may seem, the differentiation between a hæmolytic jaundice and an obstructive jaundice can sometimes be made only with the greatest of difficulty. If bile salts are not present in pure hæmolytic jaundice, and if we had a method for determining them, great difficulties would be saved. At any event, whether they are present or not in hæmolytic jaundice, it is necessary for us to have new and better analytical methods before we can progress further in this direction.

Finally, it may be remarked that these apparently academic points of capillary cholangitis, bile thrombus formation, direct or indirect entrance into the blood, and so on are really of great practical value. Within the last few years, especially among surgeons, there has been an ever increasing interest shown in the hæmolytic anemias which has culminated in the removal of spleens, in drainage of the bile passages, and in other similar procedures. I need not call attention to the interest presented by the various types of cirrhosis of the liver in which we know there are, somehow or other, close relationships to the spleen and to hæmolytic anemia in general, but just in what way, is still obscure. If the jaundice present in many of these anemias is due to bile thrombus formation or other similar participation by the liver, it is

obvious that treatments such as drainage of the common duct or cholecystoduodenostomy are of problematic use, because the obstruction is not where the drainage tube is put, but much higher up. A surgeon may answer to this argument that drainage of the common duct does relieve a number of cases, as has been shown repeatedly in clinical experience. To which we reply that in such a state of affairs, more investigation is necessary. Perhaps very careful pathological anatomical examination of the large ducts in such cases will give us some information. It is also important in connection with removal of the spleen, for bound up with this subject is the question of the primary or secondary involvement of that organ as well as of the liver. Finally, if the liver is involved in hæmolytic jaundice, it is important both medically and surgically to know the extent and character, because degenerative and inflammatory changes in this important organ are doubtless the deciding factors in recovery or death, or in the future entire well being of many patients.

Our conclusions, therefore, must be that more study is needed, first as to the details of the anatomy of the liver both under normal and pathological conditions; secondly, as to the exact relationship of the reticulo-endothelial system and the liver, and thirdly, that better chemical methods are needed for the analysis of bile. The question of the functional capacity of the liver, and its behavior in these various conditions can then be attacked to far more satisfactory degrees.

INTERNAL BILIARY FISTULA

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In the period preceding the advent of modern surgery, the fundamental conceptions of disease were based on a study of the dead, of pathologic tissue rather than of pathologic function. Disease processes were encountered in their terminal stages after nature had exhausted every effort to rid itself of the invader. Those were the days of enormous neoplasms, enormous ovarian cysts, and bizarre lesions. Fistulous communications between the biliary passages and other viscera were regarded as pathologic curiosities because of their extreme variety and unusual nature. The unrestricted wanderings of a gall-stone often embraced a wide itinerary. A review of the older books of pathology revealed many remarkable cases. Gall-stones have been vomited from the stomach, coughed up from the larger bronchi, and obtained through a stomach tube. Faber records the case of a woman who voided thirteen gall-stones with the urine. Gall-stones have been impacted in the male urethra, and have been removed from the bladder by lithotomy and by lithotrity. The gall-bladder has formed a fistula with the pregnant uterus, and stones have been passed from the vagina during labor. An ovarian cyst was found to contain bile, the result of a communication with the gall-bladder. Instances have been recorded of biliary fistulas connected with the pericardial cavity, and gall-stones have been found in a pleural effusion. The vascular system has been invaded. Realdus Columbus, at necropsy, found three gall-stones in the portal vein of Ignatius Loyola, which had penetrated from the gall-bladder. Jacob Camenicenus relates the case of a man in whom the branches of the portal vein were entirely filled by calculi.

Fistulas between the gall-bladder and some portion of the gastro-intestinal tract are relatively common, so that the passage of a gall-stone from the bowel has been regarded as nature's cure. Many of the so-called cures obtained at Carlsbad were examples of this form of spontaneous anastomosis. Unfortunately the cure is worse than the disease, and the mere presence of stones does not constitute our present conception of the pathologic condition. In view of the high incidence of gall-stones and gall-bladder disease, the occurrence of fistula must be regarded as an unusual complication. In a series of 10,866 necropsies made by Roth, Schroeder, and Schloth, biliary fistula was found forty-three times: nineteen of the fistulas were between the gall-bladder and duodenum, and sixteen were between the gall-bladder and colon. Undoubtedly, there are many instances of the condition which pass unrecognized because of the absence of symptoms.

Most of the gall-stones that enter the intestines by way of a fistula are passed from the bowel without difficulty. Certainly, stones small enough to traverse the common duct would not obstruct the lumen of the intestine. Nevertheless, in the older literature are many reports of cases of intestinal obstruction caused by gall-stones. Murchison collected thirty-seven cases of fistula from the gall-bladder to the duodenum, in the majority of which death was due to obstruction of the small intestine by a large biliary calculus. The usual sites of obstruction are in the first part of the jejunum, and the lower end of the ileum. A stone, which has ulcerated from the gall-bladder into the colon, is almost sure to pass. It is possible that a stone after entering the intestine may increase in size and assume the character of an enterolith. In the present day when surgery has made possible the study of living pathology, this unusual complication of gall-bladder disease is still encountered at the operating table, but cannot be regarded as nature's cure. A fistulous communication with some part of the gastro-intestinal tract is a life-saving event, so far as perforation of the gall-bladder is concerned, but the infected viscus remains as a menace to health. It is probable that all the stones are not discharged through the fistula, and in many instances stones re-form in the diseased gall-bladder. Acute perforation of the gall-bladder into the free peritoneal cavity is rare and oftentimes fatal because of the septic contents. The anatomic position of the gall-bladder is such that acute inflammation in its walls quickly forms adhesions to surrounding organs. The fundus of the gall-bladder lies near the end of the ninth right costal cartilage. Anteriorly the bladder rests on the transverse colon, behind which it lies first to the right of, and then above the first part of the duodenum.[10]

This study is based on 153 cases of internal biliary fistula in which operation has been performed in the Mayo Clinic. Post-mortem material has been eliminated; also cases of rupture of the gall-bladder into the substance of the liver, or into a closed abscess cavity. One hundred eleven of the series were females and forty-two were males. The greatest percentage of cases occurred in the sixth decade of life, which is accounted for by the unusually long duration of symptoms in this group of cases. One patient was between twenty and thirty years of age; seventeen were between thirty and forty; forty-five were between forty and fifty; sixty-three were between fifty and sixty; twenty-five were between sixty and seventy, and two were between seventy and eighty. Many patients had had trouble for twenty-five or thirty years; twenty had had symptoms for twenty or more years; the longest duration was forty years, and the shortest one month; the average was ten years.

SYMPTOMS AND DIAGNOSIS

In a study of the histories of these patients, it was noted that a considerable number had had severe symptoms of gall-bladder disease, with hepatic colic, jaundice, chills and fever, for from fifteen to twenty years previous to examination in the Clinic. Then, following a particularly severe attack, all symptoms were apparently relieved for six or eight years. The period of apparent

well-being probably followed the formation of the fistula. The recurrence of the former symptoms may be due to many causes. Discharge of bile by a fistula into the stomach is well tolerated, and the findings of such fistulas at necropsy suggested the operation of cholecysto-enterostomy. It is well known that an anastomosis between the gall-bladder and the stomach or duodenum functions only so long as the common duct is obstructed and the cystic duct remains patent. When these conditions do not obtain, the lumen of the spontaneous, as well as that of the surgical anastomosis, tends to contract and close. Many instances of healed fistulas are encountered at operation. The size of the fistula is originally the size of the largest stone which has passed through it; later it contracts. In the cases in this series, the lumen varied from several centimetres in diameter to a mere opening. The gall-bladder is always diseased, and is usually small and contracted. It may contain foul bile, duodenal contents, pus, and stones. It may be distended with gas. So long as the fistulous opening is free, there is provision for drainage of the gall-bladder; but should the opening become obstructed by fibrous contraction, or plugged by a stone, especially if the cystic duct is obliterated, a closed septic cavity is formed. Thus, it is evident that the formation of an internal biliary fistula affords at best only temporary relief, and there is considerable chance for the recurrence of serious trouble (Table I).

TABLE I

Symptoms

	Patients
Colics	130
Colics with jaundice	78
Fever	67
Jaundice with dull pain	8
Dull pain only	14
Common duct obstruction	36
Passed stone by bowel	7
Intestinal obstruction caused by stone	1

The symptoms of these patients did not differ materially from the usual symptoms of gall-bladder disease, except that they were more severe, and were definitely indicative of disease of the biliary tract. One hundred thirty patients had repeated attacks of severe hepatic colic; seventy-nine had associated jaundice. Jaundice without colic, but with dull epigastric pain, was present in eight cases. Fourteen patients did not have colic or jaundice, but complained only of epigastric pain accompanied by more or less reflex gastric disturbance. Seven patients said that they had found gall-stones in the stools, but only one patient gave a history of intestinal obstruction, and operation revealed a gall-stone as the cause. Thirty-six patients had definite symptoms of obstruction of the common duct, consisting of colic, jaundice, absence of bile in the stools, and in many instances chills and fever.

Forty of these patients were markedly jaundiced when they presented themselves at the Clinic; one of the forty had had constant jaundice of varying intensity for two years. Sixteen had palpable tumors in the right upper quadrant of the abdomen. It is remarkable that, of the many instances in which an X-ray examination was made after a barium meal, evidence of a duodenal fistula was found in only one case. Carman explains this by his method of routine X-ray examination, in which the cap is the only portion of the duodenum that is distended, and this, for a short time only. The barium then passes into, but does not distend the remainder of the duodenum. It is possible that by filling the duodenum by retention of the barium, and making plates after a longer interval, a duodenal fistula could be visualized. We believe that a review of the literature will show that diagnosis of an internal biliary fistula between the gall-bladder and duodenum is rarely made by the Röntgen ray. Carman refers to a case of carcinoma of the pylorus which had perforated into the gall-bladder, in which he was able to demonstrate by the X-ray the presence of barium in the fistulous tract, as well as in the gall-bladder, and in the bile ducts.

The actual diagnosis of the presence of an internal biliary fistula is not of much practical importance, and is rarely made during the clinical examination; it is usually an accidental finding at the operating table. The patients present well-defined symptoms of disease of the biliary tract for which surgical intervention is indicated. The diagnosis of a fistula between the gall-bladder and intestinal tract was made in only two of the 153 cases. In these two cases the fistulas were between the gall-bladder and colon, and one was demonstrated by the X-ray after a barium enema. A regional diagnosis, namely, gall-bladder disease, was made in 128 cases, and in twenty-eight, obstruction of the common duct was suspected. The gastric symptoms sometimes predominate, and a diagnosis of duodenal ulcer was made in six; of pyloric obstruction in three; and of tumor of the stomach in two cases, without definite indications of disease of the biliary tract. Two patients were thought to have appendicitis, and carcinoma of the liver or pancreas was suspected in one case because of the jaundice and cachexia.

FINDINGS AT OPERATION

Adhesions between structures in the right upper quadrant of the abdomen are very common, and should be carefully dealt with because of the variety of lesions which may be uncovered. With disease of the gall-bladder this organ is often found adherent to the stomach, duodenum or colon, and in this event, the gall-bladder should be carefully separated by dissection from the adherent viscus, and the presence or absence of a perforation definitely determined, because failure to recognize an opening in the bowel, which may be very small, may result in a spreading peritonitis. The presence in the gall-bladder of foul bile or frothy thick mucus should arouse suspicion of a fistula. All of the gall-bladders in this series of our cases were markedly diseased; usually the walls were thickened; often the organ was contracted or completely

destroyed (Table II). In our series, the relative frequency of biliary fistula with the duodenum is more than four times greater than with the colon, and communication with the stomach is the least common (4 per cent.). In 384 cases of biliary fistula collected by Courvoisier and Naunyn, ninety-three were with the duodenum, forty-nine with the colon, and eight with the stomach. The opening in the stomach is always at or near the pylorus, and is usually small, probably the result of muscular contraction. The opening in the duodenum is commonly in the first or upper part of the second portion. In ten cases

TABLE II

Findings at Operation

	Cases	
Fistula with duodenum	117	
Fistula with duodenum and colon	4	
Fistula with stomach	6	
Fistula with colon	26	
		153
Fistula from gall-bladder to duodenum	148	
Fistula from common duct to duodenum	1	
Fistula from cystic duct to duodenum	4	
Fistula by direct communication	148	
Fistula by abscess	5	
Stone in transit in fistula	11	
Stones in gall-bladder	76	
Stones in cystic duct	13	
Stones in hepatic duct	11	
Stones in common duct	55	
Empyema of gall-bladder	9	
Cholangeitis	5	
Pancreatitis	46	
Associated lesions:		
Gastric ulcer	2	
Duodenal ulcer	10	
Carcinoma of gall-bladder	1	
Carcinoma of pylorus	1	

there was an ulcer of the duodenal cap which was separate and distinct from the fistulous opening. Robson says that he has known ulcer of the pylorus and of the duodenum to perforate into the bile passages. The inflammation and fibrosis incident to fistula with the pylorus or duodenum may cause marked diminution in the lumen and sometimes actual obstruction. In certain cases, after separation from the gall-bladder, there remains an area of thin scar tissue in the duodenal wall, and in the absence of an opening in either the gall-bladder or duodenum, there is a question of whether the condition represents a chronic perforating duodenal ulcer or a healed fistula. The portion of the colon involved is the hepatic flexure. In one of the twenty-six cases in the series, there were two openings between the gall-bladder and colon. Murchison collected nine cases of gall-bladder-colon fistulas, in six of which

there was carcinoma of the gall-bladder. In this series there were only two cases of carcinoma; one was primary in the pylorus and had perforated into the gall-bladder; the other was primary in the gall-bladder and had perforated into the duodenum.

Internal biliary fistulas usually lead from the gall-bladder. In only one of the cases was the common duct the point of origin, and in four the cystic duct communicated with the duodenum. We are not aware of any case in the literature in which the fistula originated in the hepatic duct. The fistula usually leaves the gall-bladder from the fundus; occasionally the exit may be from the pelvis or neck. It has been asserted that in cases in which exploration of the common duct reveals an unusually large opening into the duodenum, the actual condition is a fistula between the lower end of the duct and the duodenum. Such cases are not included in this series.

In all probability perforation with the formation of a fistula does not take place in inflammatory disease of the gall-bladder in the absence of complicating lithiasis. In other words, local ulceration and necrosis resulting from the presence of a stone is the cause of fistula. In only thirty-two of 153 cases of fistula were stones absent from the gall-bladder or ducts, and undoubtedly in most of these, stones were present originally. A stone in transit, that is, present in the lumen of the fistula, was found in eleven cases. The gall-bladder contained stones in seventy-six cases, and in forty-eight of these the stones were confined to the gall-bladder and absent from the remainder of the biliary tract, while the cystic duct contained stones in thirteen cases, it was obliterated or obstructed in five as the result of inflammation. Stones were found in the common duct in fifty-five cases, and in three the duct was obstructed in the absence of stones.

It is indeed evident from the foregoing that temporizing or delay in diseases of the biliary tract may result in spontaneous evacuation of calculi with a temporary lull in the severity of symptoms, but subsequent and more dangerous complications are likely to ensue. At present the best method for the prevention of such conditions is removal of the gall-bladder in the early stage of disease.

OPERATIVE PROCEDURES

As has been stated, a gall-bladder firmly adherent to a neighboring viscus should suggest the presence of an inter-communicating fistula, and the adhesion should be carefully separated by sharp dissection close to the gall-bladder. The opening in the stomach, duodenum, or colon may be very small, and even if the opening cannot be demonstrated, the area should be very satisfactorily covered by infolding suture. When the aperture in the bowel is visible, it should be closed by over-sewing with chromic catgut or linen, or by a purse-string suture. Sometimes, when the gall-bladder is separated, a stump of fistula projects from the bowel. This can be ligated and inverted like the stump of an appendix. When the opening in the duodenum has been closed, the lumen of the bowel may be sufficiently compromised to cause obstruction,

and in the judgment of the surgeon a gastro-enterostomy may be indicated. In this series it was found that a gastrojejunostomy was required in twelve cases because of duodenal or pyloric obstruction, or duodenal ulcer. After the opening in the bowel has been closed, attention is directed to the biliary tract. Since the gall-bladder is always diseased, it should be removed whenever local and general conditions permit. In one case in which it seemed best to drain the gall-bladder after separation and closure of the fistula, subsequent events necessitated a second operation, at which time it was found that the fistula had recurred (Table III).

TABLE III

Type of Operation

	Cases
Closure of fistula and cholecystectomy	67
Closure of fistula, cholecystectomy, choledochostomy	54
Closure of fistula and cholecystostomy	10
Closure of fistula, cholecystostomy, choledochostomy	8
Closure of fistula and choledochostomy	5
Cholecystostomy	4
Cholecystostomy and choledochostomy	1
Choledochostomy	2
Cholecystectomy and choledochostomy	1
Cholecystectomy and pyloroplasty	1
Additional procedures:	
Gastro-enterostomy	12
Jejunostomy	2
Excision of gastric ulcer	1
Excision of duodenal ulcer	1
Polya resection of stomach	1

When the gall-bladder is densely adherent, and there is marked local infection, or when there is deep jaundice, it is unwise to attempt cholecystectomy. In view of the high incidence of stones in the hepatic and common ducts in these cases, and the frequently associated infection, exploration and drainage of the ducts will be indicated in many instances.

RESULTS

No attempt has been made to trace these patients for long periods after operation, the immediate results being the chief point of interest. Sixteen of the 153 patients died in the hospital. The mortality for uncomplicated cholecystectomy is about 1 per cent., and relief is obtained in nearly 90 per cent. of cases. The mortality and morbidity of surgical diseases of the biliary tract, other things being equal, is directly proportional to the duration of symptoms. The mortality is that of delay and not of operation.

In 144 cases an intestinal or gastric fistula was closed by suture; the majority were duodenal, yet only two patients developed intestinal fistula in the wound after operation. One of these patients died as the result of a duodenal fistula; the fistula of the other closed spontaneously. Seven patients

returned to the Clinic for second operations; one had a recurrence of the fistula; one had pyloric obstruction which required a gastro-enterostomy, and five required some type of operation on the biliary tract, usually cholecystectomy.

SUMMARY

Internal biliary fistula is a late complication of cholelithiasis. It rarely occurs in the absence of calculi. The organs involved and the order of frequency are duodenum, colon, and stomach. The fistula is nearly always by direct communication; only rarely is there an intervening abscess cavity. The symptoms are characterized by long duration and severity. Intestinal obstruction is an unusual sequela. Diagnosis is usually made only at the operating table. Formation of a spontaneous internal biliary fistula is in no sense a cure of cholelithiasis, but is an additional and dangerous complication. The treatment of the condition when found is closure of the fistula, cholecystectomy when possible, and careful exploration of the ducts for stones. Emergency drainage of the gall-bladder and ducts may be the only logical procedure in some cases. Separate lesions in the stomach or duodenum may be complicating factors. The unnecessarily high mortality is a direct result of delay of the patient in coming to operation.

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HOUR-GLASS STOMACH AND DUODENUM

By Charles Horace Mayo, M.D.
of Rochester, Minn.

The hour-glass or bilocular stomach, formerly comparatively rare, has been reported by so many observers that the condition has been robbed of its former position as an uncommon lesion. The condition occurs frequently enough to be considered by the careful clinician in the analysis of certain gastric symptoms. The fact that hour-glass stomach forms a fairly definite percentage of gastric lesions is important to remember.

The stomach may be constricted in the upper, middle or lower portion, with a consequent variation in the size of the loculi. The narrowing may be caused by extrinsic or intrinsic tumor, benign or malignant, by central linitis plastica in the early stage without large loculi, or by inflammatory products which are commonly accompanied by ulceration. With ulceration there may be extensive inflammatory thickening and calloused induration, or a small ulcer may appear without a calloused condition, but with a surprising amount of tissue missing and unaccounted for by the appearance of the ulcer, which nevertheless has greatly reduced the gastric lumen at the point affected. The special destruction of the tissue may be due to a spastic contraction of a band of circular muscle, controlled by the sympathetic nervous system. Probably a combination of ulcer and spastic contraction ordinarily accounts for hour-glass stomach. Contraction of the mucous lining of the stomach occasioned by a small gastric ulcer drawing the mucous membrane together like a Houston valve of the rectum without external incisura, is a rare but possible condition, as illustrated by the case reported by Andrews. Constrictions and tumors of the stomach of syphilitic origin have been reported by a few observers. Inflammatory bands attached to the liver, pancreas, or abdominal wall, whose development is occasioned by perforating gastric ulcer, or by causes extrinsic to the stomach may partially divide the stomach into two compartments. A constriction, with displacement of the lower loculus of the stomach to one side of the upper, by extrinsic gastric tumors, has led to the term "cascade stomach," the contents pouring out of the upper into the lower loculus.

In general, the symptoms of hour-glass stomach are those of obstruction from unknown causes, such as ulcer, bands, benign and malignant growths, and vary according to the age of the patient, and the location and extent of the lesion. When the condition is caused by ulcer, there is considerable variation in the severity of the symptoms, dependent on the degree of obstruction in relation to the degree of acidity, which is commonly moderate, but occasionally is high or low. In a few cases hyperchlorhydria is present. In some cases the suffering is not great, and but little attention is paid to the trouble until late, when partial obstruction is the essential symptom. The benign conditions

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In general, the symptoms of hour-glass stomach are those of obstruction from unknown causes, such as ulcer, bands, benign and malignant growths, and vary according to the age of the patient, and the location and extent of the lesion. When the condition is caused by ulcer, there is considerable variation in the severity of the symptoms, dependent on the degree of obstruction in relation to the degree of acidity, which is commonly moderate, but occasionally is high or low. In a few cases hyperchlorhydria is present. In some cases the suffering is not great, and but little attention is paid to the trouble until late, when partial obstruction is the essential symptom. The benign conditions

usually develop slowly. Pain is more commonly associated with active ulceration and complications of perforation or surrounding peritonitis with adhesions. The diagnostician of long experience may suspect the condition, and the stomach tube and test meal with loss of lavage water may give corroborative evidence.

In the early period of gastric surgery, before the X-ray was perfected, great progress was made by Moynihan, Wolffer, and von Eiselsberg, who contributed data enabling the clinician to make the diagnosis with sufficient accuracy to advise operation. To-day the greatest dependence is placed on the expert röntgenologist who, by his fluoroscopic examination and photographic plates of the gastric lesion, is able to present all the evidence necessary, when considered with the history and laboratory tests, for a complete analysis of the condition, including its probable cause and the degree of obstruction. A decision can then be made as to the necessity for operation, and the type best suited to the individual case.

TREATMENT

In rare cases a benign growth in the stomach, which can be readily resected, is the cause of the lesion. A constriction due to cancer usually is irregular, and the communicating canal is much longer than in the benign condition. Unfortunately, the X-ray does not reveal glandular involvement or metastasis. Sometimes the condition is so far advanced that the glands in the neck are invaded by way of the chyle duct, and there are tumors in the liver, secondary tumors in the abdomen, the omentum, and the mesentery. Also the pelvic structures may be secondarily involved, or ascites may be a complication in a very late stage when the disease is hopeless, and surgery futile even for palliation. In three of four cases of cancer of the stomach the lymph-nodes are involved early, and surgery is beneficial only if undertaken early. In approximately 25 per cent. of cases the growths are confined to the stomach or to the nodes on its wall, and the various procedures, sleeve resection, excision of the growth with the lower segment, and the posterior Polya, or the anterior Polya-Balfour operation, may be possible, uniting the divided end of the upper loculus of the stomach to the jejunum.

In cases of ulcer, sleeve resection is often possible, or removal of the lower segment and anastomosis of the narrowed area of the upper loculus just above the ulcer to the duodenum may be successfully accomplished. In some cases it may be necessary to perform an anterior or posterior type of Polya operation and closure of the duodenum, resecting the contracted area, attaching the proximal end of the divided stomach to the upper jejunum through the mesentery of the transverse colon as a posterior Polya, and closing the upper end of the lower loculus which delivers its secretion into the duodenum as before. This is the operation which Devine, of Australia, recommended for the treatment of ulcer. The condition of the patient, the presence of adhesions, local peritonitis, and other factors, may modify previous plans of procedure; the

Murphy button has been employed to unite the upper and lower segments of the stomach, and suture anastomosis is used for the same purpose. The application of the Finney pyloroplasty as a plastic enlargement of the narrowed connecting part of the stomach, may, in certain cases, be the operation of choice. These more palliative operations, however, do not deal with the ulcer which should be removed, although such operations will relieve the obstruction. The break in harmony between the acid and alkaline secreting

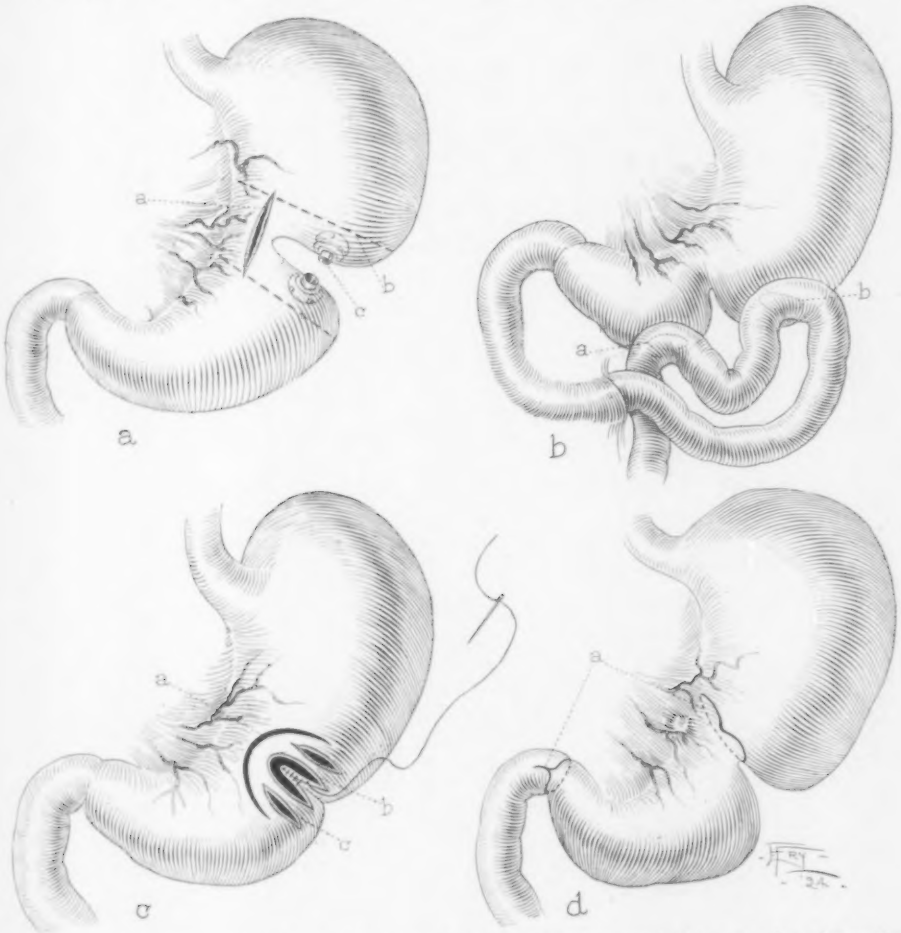

FIG. 1.—a. Sleeve resection, Murphy button and Heineke-Mikulicz operations. b. Anterior gastro-enterostomy. c. Finney gastrogastrostomy and Mayo operations. d. Mayo operation.

hormones of digestion with pylorospasm may favor the development of ulcer. A single anterior gastro-enterostomy on the upper loculus with a loop of jejunum has been recommended and practiced, also a second gastro-enterostomy, uniting the same loop to the lower loculus. I have been partial to the sleeve resection in the benign cases, and when conditions were favorable have removed the lower segment of the stomach, uniting the narrowed portion above the ulcer to the end of the duodenum, protecting this pos-

TABLE I.

One Hundred Eighty-seven Cases of Hour-glass Stomach and Duodenum Observed Between January 1, 1906 and January 1, 1924.

	Benign gastric ulcer	Per cent.	Gastric cancer	Per cent.	Gastric syphilis	Per cent.	Miscellaneous	Per cent.	Hour-glass duodenum	Per cent.
Cases	118	63.10	25	13.36	6	3.20	10	5.34	28	14.97
Hospital mortality*	2	1.69	3	12.00			1	10.00		
Subsequent deaths	17	14.65	15	68.18	1	16.66			2	7.14
Average age		Years		Years		Years		Years		Years
Males	30	47.43	15	53.60	3	32.66	4	46.00	20	45.70
Females	88	41.85	10	42.40	3	30.33	6	39.33	8	38.50
Average duration of symptoms		11.13		3.78		2.70		1.15		14.37
Onset of pain, hours after meals:										
Immediately to 2	15		2		2		2		2	
0.5 to 3	7		3				3		1	
1.0 to 4	25		2				3		3	
1.5	1									
2.0 to 4	28		8				1		10	
3.0 to 4	7		2						9	
4.0 to 6	1									
5.0	1									
Time not stated	32		8		3		1		3	
No pain after meals	1				1					
		Per cent.		Per cent.		Per cent.		Per cent.		Per cent.
Cases of emesis	79	66.94	13	52.00	4	66.66	2	20.00	15	53.57
Cases of hæmatemesis	37	31.35	5	20.00					5	17.85

Of the 1596 cases of benign gastric ulcer, hour-glass constriction occured in 118 cases (7.39 per cent.).
Of the 6664 cases of duodenal ulcer, hour-glass constriction occured in 28 cases (0.42 per cent.).

* Total hospital mortality 3.2 per cent.

TABLE II.

Hour-glass Stomach and Duodenum January 1, 1906 to January 1, 1924.

	Benign gastric ulcer	Cancer	Syphilis	Miscellaneous	Duodenal ulcer
Relief from pain by:					
Food	57	16		4	24
Soda	49	7		5	19
Emesis	42	3	1	1	5
Morphin	4	1			2
Whiskey	2	1			
Heat	3				1
Lavage	2				4
Pressure	1				1
Hot drink	3				4
Diet	2		1		3
Belching	1				
Posture		2			2
No relief	2	1			
Average loss of weight (pounds)	18.61	22.14	32.2	22.71	21.78
Average total acidity	46.15	38.5	20.6	49.9	62.08
Average free hydrochloric acid	34.96	32.0	30.0	38.22	51.88
Findings at operation:					
Perforation	49	6		1	3
Adhesions	29	1		7	5
Callous	13	4			8
Obstruction	15	4	2	1	17
Location of ulcer or cancer:					
Lesser curvature	44	9			
Lesser curvature and posterior wall	26	4			
Greater curvature	3	3			
Posterior wall	19	3			2
Posterior and superior walls	2				2
Posterior and anterior walls	1				1
Posterior, superior walls and lesser curvature	2				
Anterior wall	3	1			8
Anterior wall and lesser curvature	1				
Anterior and superior walls	1				8
Lesser curvature and all walls	1				
Above pylorus (1.5 to 7 inches)	27	8			
Below pylorus	2				19
Pyloric end	6				1
Near cardia	11				
Middle stomach	4	3			
At incisura	5				
Upper margin of duodenum					1
In old suture line (gastrojejunal ulcer)	1				
Not stated	13	3			1

TABLE III.

Results of Operation in 187 Cases of Hour-glass Stomach and Duodenum.

Benign gastric ulcer—Types of operation	Operations	Hospital deaths	Complete cure			Pair cure			Not cured			No report
			Cases	Subsequent deaths	Subsequent operations	Cases	Subsequent deaths	Subsequent operations	Cases	Subsequent deaths	Subsequent operations	
Gastrogastrostomy	20	1	10		2	2			5	1	1	2
Gastrogastrostomy and Finney pyloroplasty	1					1		1				
Gastrogastrostomy (Finney) and posterior gastro-enterostomy	6		4	1					1		1	1
Gastrogastrostomy, closing old gastro-enterostomy, excision of ulcer and new gastro-enterostomy made	1								1		1	
Gastroplasty	1		1									
Gastrogastrorrhaphy	5		4						1			
Witzel jejunostomy	1								1	1		
Plastic duodenostomy and adhesions separated	1								1			
Posterior gastro-enterostomy	14		8	4					5	3		1
Posterior gastro-enterostomy and pylorus blocked	1					1		1				
Posterior gastro-enterostomy and division of band causing hour-glass	1											1
Posterior gastro-enterostomy and gastrogastrorrhaphy	1		1		1							
Anterior gastro-enterostomy	1								1	1		
Excision	2		1						1			
Excision and anterior gastro-enterostomy	1		1	1								
Excision and gastrogastrostomy	5		4	1	1	1						
Excision and plastic	3		3									
Excision and posterior gastro-enterostomy	2								2		1	
Suture excision of ulcer and Finney gastrogastrostomy	1		1									
Excision, old gastro-enterostomy cut off, new one made, and plastic closure	1					1						
Cautery excision	2								1			1
Cautery excision and posterior gastro-enterostomy	13		7			1			2			3
Cautery excision and anteroposterior gastro-enterostomy	1											1
Cautery excision and gastrogastrostomy	1		1									
Cautery excision, knife excision, and posterior gastro-enterostomy	2								1			
Cautery excision, knife excision, posterior gastro-enterostomy and plastic	1		1			1			1			

Cautery excision, posterior gastro-enterostomy and plastic	1		1									
Sleeve resection	15		9	1	1	1			5		1	
Sleeve resection and posterior gastro-enterostomy	1		1									
Sleeve resection and plastic	1					1						
Partial gastrectomy and posterior Polya	3								1			2
Partial gastrectomy, posterior Polya and old gastro-enterostomy cut off	1					1						
Partial gastrectomy and anterior Polya	3		2						1			
Partial gastrectomy and Finney pyloroplasty	1											
Billroth No. 1	2	1	1									
Two-stage operation	1		1	1								
Total	118	2	62	9	5	11	0	2	31	6	5	12
Cancer of Stomach												
Gastrogastrostomy	2								1	1		1
Gastrogastrostomy and anterior gastro-enterostomy	1	1										
Pyloroplasty	1								1	1		
Posterior gastro-enterostomy	3								3	3		
Anterior gastro-enterostomy	3								2	1		1
Excision and posterior gastro-enterostomy	1											1
Transgastric excision and gastrogastrorrhaphy	1											1
Cautery excision and posterior gastro-enterostomy	1								1	1		
Sleeve resection	2		1						1	1		
Partial gastrectomy and posterior Polya	2								2	2		
Resection, anterior Polya in "Y" and entero-anastomosis	1								1			
Exploration	6	1							5	4		
Cautery excision and plastic on pylorus	1	1										
Total	25	3	1						17	14		4
Syphilis of Stomach												
Gastrogastrostomy	1		1									
Gastrogastrostomy, pyloroplasty and dilatation of œsophagus	1								1			
Witzel jejunostomy	1								1			
Sleeve resection and jejunostomy	1		1									
Partial gastrectomy and posterior Polya	1					1						
Billroth No. 1	1								1	1		
Total	6		2			1			3	1		

TABLE III.—*Continued.*

Results of Operation in 187 Cases of Hour-glass Stomach and Duodenum.

Benign gastric ulcer—Types of operation	Operations	Hospital deaths	Complete cure			Fair cure			Not cured			No report
			Cases	Subsequent deaths	Subsequent operations	Cases	Subsequent deaths	Subsequent operations	Cases	Subsequent deaths	Subsequent operations	
Miscellaneous												
Gastrogastrostomy	2		2									
Posterior gastro-enterostomy	4		1			2						1
Old scar excised, adhesions separated and posterior gastro-enterostomy	1								1			
Cut off old gastro-enterostomy and plastic closure	1		1									
Exploration	1	1										
Band excised and both ends closed	1											1
Total	10	1	4			2			1			2
Duodenum												
Posterior gastro-enterostomy	21		11	1	1	4	1		5		1	1
Posterior gastro-enterostomy and pylorus blocked	3		2			1						
Posterior gastro-enterostomy and ulcer enfolded	1		1									
Excision and plastic	1		1									
Cautery excision	1											1
Cautery excision and posterior gastro-enterostomy	1											1
Total	28		15	1	1	5	1		5		1	3
Grand total	187	6	84	10	5	19	1	2	57	21	6	21

teriorly by a layer of omentum, and covering the anterior suture line with a second loosely applied layer of omentum or adjacent fat. The open end of duodenum is divided anteriorly to enlarge its perimeter for suture; 1 or 2 cm. is usually sufficient. The latter operation is quickly and satisfactorily performed.

Hour-glass duodenum is less common, but does occur. It is usually due to an encircling ulcer just above the common duct. Rarely it may be due to an adenoma growing from the inner wall of the bowel. As a result of inflammatory bands from a diseased gall-bladder, bands may cross the duodenum and cause partial obstruction. The duodenum is distended above the constriction, and also relaxed and larger below; the terminal duodenum passing through the mesentery of the ulcer may be constricted and require freeing. The stomach and the pylorus are dilated.

Treatment.—When bands are the cause of the constriction they may be removed; when tumors are the cause, these are best removed by opening the bowel. The circular ulcer is usually too inflammatory for safe resection, and a posterior gastro-enterostomy or a Polya operation made after Devine's method without removal of the lower segment of the divided stomach may be the simplest and safest procedure. (Tables I, II and III.)

DIVERTICULITIS OF THE COLON

CLINICAL TYPES AND TREATMENT

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FROM THE SURGICAL SERVICE OF THE ROOSEVELT HOSPITAL

Diverticulitis of the colon occurs with greater frequency than was formerly recognized. It is a disease of middle life, more frequent in males than females; often associated with obesity, and poor general muscular tone. The presence of multiple diverticula of the colon without symptoms, discovered by X-ray examination, while in direct causal relation to diverticulitis must not be confused with it, as many cases exist which never develop inflammation or other pathologic changes. The question is brought up from time to time in patients in whom search is being made to find a focus of infection to explain remote constitutional disturbances (*e.g.,* joint symptoms), as to whether the retention of hardened fecal masses in diverticula may act as such a focus. Unless there is some evidence of an actual diverticulitis or inflammatory process, it seems unlikely that such a relationship could be assumed.

While diverticula may occur in any part of the colon or elsewhere in the intestine, they are rarely of clinical significance except in the sigmoid, descending colon or recto-sigmoid. Much has been written as to the etiology and pathology of these diverticula, but beyond the fact that they are small herniæ of the mucous membrane of the bowel through a thinned and weakened musculature, little of importance is known. They frequently develop into appendices epiploicæ; into the fat at the mesenteric border, or at the site of vessels in the gut wall. They tend to lodge hardened masses of fecal matter, which may by pressure ulcerate through and cause perforation, or else by irritation cause a low grade type of productive inflammation and general thickening of the gut wall.

The secondary pathologic changes are of two general types:

1. Those dependent on extension of the inflammatory changes to structures outside the bowel wall, *e.g.,* acute perforation with diffuse peritonitis; localized peritonitis with abscess; localized plastic peritonitis without abscess; abscess in the mesentery or an epiploic appendage; perforation into a hollow viscus; or rupture of an abscess to the surface.

2. Diffuse inflammatory thickening of the bowel wall with tumor formation stimulating carcinoma, or general thickening and contraction of a segment of the gut.

The following illustrative cases are recorded from their bearing on clinical types of the disease.

CASE I.—Male, forty years. *Acute perforation of sigmoid diverticulitis with extensive diffuse peritonitis.* The patient, a prominent actor, was taken ill with abdominal pain about 6:00 P.M. on January 8, 1917; with the aid of a small dose of morphine he went through his evening's performance, returning to his apartment about midnight the pain much worse. When seen in consultation at 8:00 P.M. the following evening he was very ill with signs of wide-spread diffuse peritonitis.

Operation was performed at 10:45 P.M., and with a provisional diagnosis of ruptured appendix, a right side incision made, and a large quantity of free purulent fluid evacuated. Neither appendix nor cæcum could be found, but a mass was felt in the region of the sigmoid well to the left. A second incision through the left rectus revealed a perforation of the lower sigmoid on its right aspect, a partly localized abscess with pus of fecal odor, and wide-spread peritonitis. Drainage of the abscess was established, and a drain also carried to the pelvis through the right abdominal wound.

A fecal fistula developed in the left drainage track leading down to the perforated sigmoid, closing spontaneously in twenty-two days. Good ultimate recovery ensued, and patient is now well never having had any recurrent symptoms of diverticulitis.

CASES II and III.—We have seen one other case of diffuse peritonitis following acute rupture of sigmoid diverticulitis, proven by operation and autopsy, in a man of fifty years; and a third case, fatal from peritonitis in a man of fifty-two years, typical clinically in history and signs pointing to a sigmoid perforation, but moribund when first seen, and not proven by operation or autopsy.

CASE IV.—A case illustrative of a perforation partly localized occurred in a man fifty-eight years of age. Pain in left lower abdomen began six days before operation, was moderate for the first three days, then more severe with fever and leucocytosis. With symptoms increasing in severity he was brought from the South by special train, a twenty-six hour trip, and operated upon immediately after arrival, on March 19, 1923.

There was diffuse peritonitis, limited to the region of the lower sigmoid and pelvis; with an abscess in mesentery of the recto-sigmoid into which the diverticulitis had perforated.

Drainage was established through a separate incision just above Poupart's ligament, and the left rectus incision closed by suture. The peritonitis subsided; the wound drained profusely with gas and moderate fecal leakage. The fistula persisted for several months, closing and reopening until September, when healing became complete and he was quite well until January 30, 1924. Slight pain over the lower sigmoid region then developed, and a boggy, tense mass was felt per rectum, on the right wall, opposite the site of the former fistula.

The mass persisted, with little pain or discomfort for four weeks, when on February 25 an examination was made under anæsthesia with the intention of proceeding to explore or open an abscess if necessary. As shrinkage of the mass had evidently taken place, nothing further was done, and it ultimately disappeared. There has been no further recurrence of symptoms. The mass was probably due to inflammation of another diverticulum, rather than to pocketing in the former fistulous tract.

CASE V.—A case illustrating the varying site of perforations occurred in a man of forty-five years, who was admitted January 13, 1913, with an abscess in the left lumbar region, thought to be peri-renal in origin. It was opened and drained. The pus was of colon bacillus origin, and a fecal fistula developed in the drainage track. This persisted for more than three months, and as it showed no signs of healing, an abdominal operation was performed April 19, 1913. A posterior perforation in the descending colon communicating with the fistula was found and closed by suture, with good healing and no further leakage.

CASE VI.—A case illustrating spontaneous rupture into adjacent viscera occurred in a woman of forty years, who was first seen January 5, 1912. Fifteen years before an abdominal operation had been performed the nature of which she did not know, except that it was on the pelvic organs. One month before examination a fecal fistula

had opened and discharged through the vagina. Except that it was high up its exact site could not be located. Expectant treatment was advised, and continued for fifteen months, until finally on her insistent demand, operation was performed on April 10, 1913. The fistula proved to be a sigmoid diverticulitis which had ruptured into the cervical canal, of the stump remaining after a supra-vaginal hysterectomy. Closure by suture was attempted but failed as the fistula reopened both through the vagina and in the abdominal wound. Six months later, October 1, 1913, resection of the thickened segment of the sigmoid with the fistulous tract was performed and a tube anastomosis made, with a colostomy opening above, in the descending colon. Two subsequent operations were required for closure of the colostomy opening (March 19, 1914), and repair of the large ventral hernia (February 14, 1916) with ultimate complete recovery.

We have seen a number of cases of diverticulitis with typical clinical symptoms, several with distinct masses in the sigmoid region, in which the symptoms have subsided, without operation. Some of the patients have gone for long periods without recurrence, in others recurrent attacks have occurred.

Case VII.—A physician forty-four years of age had a typical attack of four days' duration when seen in consultation on April 28, 1913. A mass the size of a hen's egg could be felt in the sigmoid region, moderately sensitive. No fever nor constitutional symptoms. While it was thought to be a diverticulitis, exploration was advised for fear of the possibility of neoplasm. This was refused; he made a complete recovery and has had no recurrence of the symptoms except occasional mild local pain, now eleven and one-half years after the attack.

Case VIII.—A prominent educator, seventy-six years of age, was seen in consultation on October 19, 1912. He had pain, tenderness and a distinct mass in the sigmoid region, quite typical of acute diverticulitis. By the end of forty-eight hours the symptoms had begun to subside, and soon disappeared. He is still alive at the age of eighty-eight years, and has never required surgical treatment though we do not know whether there have ever been recurrent symptoms of the disease.

Case IX.—A woman of fifty years, had been under observation in two attacks, in October, 1914 and March, 1915, both of which subsided within a few days. She was subsequently operated upon by another surgeon in a third attack and made a good recovery. Simple closure of a small perforation was done.

We have had one resection of the recto-sigmoid for supposed carcinoma with recovery, which proved to be a non-malignant chronic inflammatory process, probably due to diverticulitis.

We have had no cases of carcinoma evidently combined with or developing on diverticulitis, though it is a well recognized fact that this condition is not uncommon.

We have recently had a case of extensive diverticulosis in a woman of fifty-five years who developed an attack of acute appendicitis.

The presence of the diverticulosis for which colonic irrigations had been given for some months, raised a question in diagnosis, but operation showed only a typical acute appendicitis.

We have had thirty-six cases of diverticulitis at the Roosevelt Hospital and in private practice since 1911. This includes cases in the general service under the care of different surgeons.

Thirty occurred in men and only six in women. The oldest patient was seventy-six years of age, the youngest thirty-six years.

Twenty-nine cases were operated upon with nine deaths and twenty recoveries. Four of the cases with diffuse peritonitis were operated under a diagnosis of appendicitis; acute symptoms of abscess or peritonitis were present in 80 per cent. of the operated cases.

Resection of the bowel was done five times with one death; colostomy was done three times, lateral suture of the perforation in the gut wall twice. The majority of the cases were treated by simple drainage. One death was due to pulmonary embolism occuring eleven days after drainage for perforation of the sigmoid with diffuse peritonitis of limited extent, after the abdominal condition had practically cleared up, and recovery seemed assured.

SUMMARY

1. Diverticulosis without symptoms is a common condition, and calls for no treatment.

2. Many cases of diverticulitis are capable of subsiding without surgical treatment, even when a tender inflammatory mass can be felt, though such patients should be kept under careful observation, until the danger of abscess formation or perforation has passed.

3. Perforation with localized abscess or peritonitis calls for prompt surgical interference; simple drainage being often sufficient.

4. Persistent chronic inflammatory thickening or mass with subacute symptoms, demands exploration and often resection of the bowel to exclude malignancy, or to remove a definitely thickened and diseased segment of the gut.

5. Fecal fistula when persistent and evidently incapable of healing spontaneously must be treated surgically according to the demand of local conditions. This may mean the necessity of an abdominal operation, with exposure and suture of the opening in the bowel or resection of the affected segment.

POST-OPERATIVE COMPLICATIONS OF ABDOMINAL OPERATIONS

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In direct relation to the degree to which the principle of anociation is applied in abdominal operations does the incidence of post-operative complications diminish—that is, when the operation is performed not on the lesion alone, but on the entire patient; when the abdominal wall is entirely relaxed; when the incision is ample; when the dissection is feather-edged; when the brain of the surgeon, rather than his muscles, is utilized; when the inhalation anæsthetic is kept at the lightest possible degree; when hæmostasis is meticulously assured; when the patient has been protected by a pre-operative respiratory and circulatory survey with the correction of every possible respiratory and circulatory defect, under these conditions post-operative complications are rare.

In certain conditions, however, special precautions must be exercised if dangerous sequelæ are to be obviated, and in others the unforeseen catastrophe occurs in spite of every effort toward prevention. In the latter group the possibility of *hemorrhage* at once suggests itself. In such a case if the hemorrhage is from the surgical field, prompt opening of the wound and seizure of the bleeding vessels is the immediate procedure with the prompt support of the patient by blood transfusion. If the hemorrhage is from non-operative sources, then sequestrate the blood in the extremities by the application of tourniquets around the thigh so as to block the venous but not the arterial flow and in addition prop the patient up in bed until symptoms of fainting develop. In the process of evolution a defense against death from hemorrhage has been evolved whereby as the death point approaches the coagulation of the blood increases. These two procedures, therefore, the sequestration of the blood in the extremities and the upright position will reduce the blood-pressure with a resultant approach to the fainting point, which in turn will rapidly increase the clotting time of the blood so that the internal bleeding point will be closed by a clot.

Mechanical obstruction of the intestines has always been one of the most urgent emergencies which the surgeon has to meet. Dr. J. B. Murphy stated that the mortality in acute intestinal obstruction was 40 per cent. in 1915; Deaver reported a mortality of 42 per cent. in a series of 276 cases; Sir Berkeley Moynihan has made the statement that few surgeons can show a mortality lower than 50 per cent. In these cases as in the case of internal hemorrhage it would appear that, as has been emphasized by Summer, Nature

herself has pointed out the method, namely, drainage through a high enterostomy by means of a catheter, the purpose being to prevent the fatal autointoxication which is being induced by the retrograde direction of the intestinal current. As soon as drainage has been established nothing else should be done until the vomiting has ceased and the organism has had an opportunity to establish a sufficient restoration to endure whatever operative procedures may be required to remove the cause of the obstruction.

Post-operative ileus, due to peritonitis or to trauma of the peritoneum during the operation, again requires the minimum procedure necessary to provide drainage. In these cases the utmost caution against disturbing the intestine should be exercised. Ileostomy is disappointing, enemas rarely if ever are of value. In any case of intestinal obstruction, therefore, from whatever cause, establish drainage as indicated and quit as far as surgical procedures are concerned, but proceed immediately to active constructive treatment of the patient as a whole. Give infusions of from 2000 to 3000 c.c. saline solution daily; apply hot packs over the whole abdomen; if gastric stasis is present, employ gastric lavage; assure an adequate supply of oxygen to the cells of the organism by blood transfusion; promote physiological rest and sleep of the patient as a whole and diminution of intestinal peristalsis by the Alonzo Clark opium treatment. Anæsthesia in these cases should not be carried beyond the stage of analgesia in order to avoid further reduction of the patient's reserves.

If nausea and vomiting occur after gastric operations, do not search for the cause of the vomiting, but make a simple jejunostomy by the simplest possible technic. Granting a correct technic in the performance of the gastric operation, the cause of the occasional vomiting is œdema in the tissue involved in the anastomosis. Rest and not manipulation is indicated.

The principle in critical cases of employing only the urgently demanded immediate procedure and no more is of prime importance in many other abdominal emergencies. Thus, in the case of a ruptured or gangrenous appendix, establish drainage and no more; in the case of a gangrenous gall-bladder, open the gall-bladder by the most direct and simplest possible procedure, provide drainage and no more; in gastric or duodenal perforation, suture the gastric or duodenal opening, establish a suprapubic drain and no more; in acute pancreatitis, establish drainage and no more; in extra-uterine pregnancy, evacuate the blood, remove the tube and no more. In brief, in every type of abdominal emergency perform a decompressing operation and leave whatever other procedures may be indicated until restoration has been established. The employment of the multiple stage operation will not only solve the problem presented by post-operative complications, but may be employed with equal efficiency in advance of the emergency. Thus, in the case of the jaundiced patient, after a preliminary operation is performed in which bile tension is relieved by the simplest possible drainage through a small incision

which is left open, loosely packed with iodin gauze, the major operation can safely be deferred until the whole patient has been cleared of bile. In cases of carcinoma of the large intestine, a preliminary colostomy in a case of cancer of the sigmoid or rectum, or an ileo-colonic anastomosis in a case of cancer of the cæcum or hepatic flexure with the postponement of the resection for from twelve to fourteen days as the condition of the patient demands, will obviate the complications and high mortality which attend the performance of the resection after a primary operation.

Pneumonia.—I have referred to the fact that the circulation and respiration should be thoroughly checked before operation, and if this has been meticulously done, the danger of pulmonary stasis and post-operative pneumonia will be largely obviated. During the past two years the incidence of these post-operative emergencies has been markedly reduced by the adoption of the following procedures. It may be noted that these procedures serve also to aid in the general conservation of the patient. If the slightest doubt exists regarding the condition of the myocardium, the heart is digitalized before operation; in very doubtful cases one or two courses of digitalis may be required to secure an optimum myocardial condition. In the winter time especially, the respiratory tract, beginning with the nose and nasal pharynx and continuing the examination down to the bases of the lungs, should be closely searched to determine whether or not there is any sign of a beginning or a latent infection; in case of the slightest doubt, the operation is delayed. In most cases, even if the examination of the respiratory tract presents not even the slightest indication of trouble, operation is delayed for one or more days, especially if the patient has travelled on a railway train. The slightest nasal discharge; the slightest reddening of the pharynx; any unusual sensation of the pharynx; the slightest râles at the bases of the lungs, are absolute indications for delay. We are indebted to Dr. Robert Dinsmore for the establishment of this rigid standard in our service.

In addition to these precautions, every patient in the winter-time, the fat and the aged patients always, the patient with a weakened myocardium always, is propped up in bed immediately and is turned from side to side as soon after operation as possible. In aged and feeble patients who require an upper abdominal operation, the incision is made transversely, whenever possible, as a protective measure against pneumonia, as this incision inhibits fewer of the abdominal respiratory muscles than does the vertical incision. Moreover, the transverse incision produces a less painful wound and consequently less respiratory inhibition and restraint, so that the patient can be induced to sit up almost immediately after operation.

Additional precautions against pulmonary stasis and pneumonia include the use of the warm water mattress on the operating table, camphorated oil jacket, the utmost care against exposure to drafts, and the avoidance of deep general anæsthesia, especially ether. Any patient who has had a recent acute

cold is sent home for a period of two weeks or else is kept in the hospital under close observation for at least a week in order to make sure that the infection has been completely eradicated. Examination of the mouth and teeth and nose and throat should be made a routine procedure on every patient whenever possible.

As already stated, preventive treatment of the patient as a whole, minimum operative procedures in the presence of any dangerous indication, the application of every possible method of protection in advance of the emergency should reduce the incidence of post-operative complications in abdominal surgery to the absolute minimum.

THE RATIONAL TREATMENT OF SLIDING HERNIA

By Alexis V. Moschcowitz, M.D.
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The literature appertaining to the subject of sliding hernia may be divided into three classes, good, bad and indifferent. The number of the good articles alone is, however, so large that the ignorance which still prevails is more than surprising. While hernia is an ordinary ailment, and one which has been fully recognized by the ancients, the rarer forms became recognized only with the advent of modern surgical procedures when their peculiarities or their difficult nature became apparent. Even now with all the diagnostic procedures at our command, the diagnosis of sliding hernia is well nigh impossible. This is principally due to:

(1) The exceptional rarity of the condition, so that the surgeon hardly ever thinks of the possibility of such an occurrence, and

(2) The differential diagnostic points are so trivial that a pre-operative diagnosis cannot be made with any definite degree of certainty.

I have purposely emphasized the difficulties in the pre-operative diagnostication of a sliding hernia, in order to make all possible allowances for the surgeon when he is confronted with one upon the operating table. At the operation, however, all justification abruptly ceases and there is no excuse for failure on his part to recognize the condition. Nevertheless, I have seen many mistakes by even most experienced operators.

If these mistakes are scrutinized it is found that they can be conveniently grouped under the following headings:

(1) The most common mistake is the result of a sort of bravado on the part of the operating surgeon. Wishing to make an impression upon visitors by his diagnostic acumen he calls any hernia which happens to have as hernial contents a viscus presenting a longitudinal tenia, in other words, a part of the large intestine, a sliding hernia. This shows such a gross ignorance of the pathogenesis and pathology of sliding hernia that it is entirely inexcusable. I have frequently operated on herniæ which contained, for instance, the sigmoid flexure or the transverse colon, which differed in no respect from any other simple hernia. The very fact that they were easy of execution and were readily reduced in the course of the operative manipulation, stamps them as foreign to the group of sliding hernia. This is very readily understood by a statement which I have frequently reiterated, namely that within reason, no viscus which has a complete peritoneal investment, or at least an appreciable mesentery, can be the sliding element in a hernia.

(2) The second mistake made, perhaps just as frequently, is that the operator regards a true sliding hernia as a loop of adherent intestine, which he proceeds to "liberate" in a more or less haphazard manner.

I well recollect my first experience, and I confess that at the time I did

not even have an inkling of the existence of such a pathological entity as a sliding hernia. The matter happened some thirty years ago, and as the patient made a complete and uninterrupted recovery (I do not know whether or not the operation was followed by a recurrence), I have no hesitancy to place it on record. It should serve as an excellent warning to others. The patient, as well as I can remember, was a man in the fourth decade of life, upon whom I operated for a recurrent inguinal hernia on the left side. I had no difficulty in opening the sac. When, however, I attempted to reduce the hernial contents I found that there was unusual difficulty in the reduction of one particular loop of intestine, about four inches in length, which occupied the posterior part of the sac. My complete unacquaintance with the subject of sliding hernia and my absolute ignorance led me to conclude that the particular rebellious piece of intestine which failed of reduction, was adherent to the sac, in which view I was fortified by the fact that the hernia was of the recurrent variety, in which adhesions are readily formed. I therefore proceeded to liberate these adhesions. The resulting hemorrhage was rather excessive, but controllable, requiring innumerable ligatures. Here and there the muscular coat of the intestine was injured, but was readily repaired. Fortunately the gut was not opened. Finally after considerable manipulations the prolapsed piece of intestine was sufficiently mobilized to enable me to reduce it, and I finished the operation by the usual plastic procedure.

The night succeeding the day of the operation was a restless one, perhaps more to me than to the patient. Reflecting upon the operation the true nature of things finally dawned upon me. I then saw for the first time that the hemorrhage was due to the divided branches of the inferior mesenteric artery and that I had securely ligated enough of these to devitalize the herniated loop of intestine. I had visions of impending necrosis of the gut, but nothing happened, and the patient made a complete and satisfactory recovery. I then and there determined never to be caught napping again.

In a previous article upon the subject I have set forth in detail the pathogenesis of sliding hernia. Because of the important relation of the pathogenesis to a rational treatment of the disease a short résumé of the subject is essential.

I have described a twofold mechanism which is the basis of the sliding hernia. For want of a better name I have called these: (1) The pulling mechanism and (2) the pushing mechanism.

My own observations have taught me the absolute correctness of the underlying mechanical forces, and conversations with my colleagues have led me to believe that this theory has come to be pretty universally accepted. The ultimate result of either mechanism is identical; namely, a part of the viscus whose normal habitat is the posterior abdominal wall comes to be a hernial content. Assuming this preposition to be correct, it at once becomes evident, that only such a viscus can form a sliding hernia, which is only partially covered by peritoneum; as a corollary of the above, it also follows that the viscus which is most frequently blamed as the sliding hernial content, namely

the sigmoid flexure, which is practically completely covered by peritoneum, can never be the sliding part of a sliding hernia.

At this point it might with perfect propriety be asked, what is the difference in the end result in the herniæ produced by these two mechanisms? A little reflection soon makes it evident that the final difference is only one of size, in as much as a hernia resulting from the pushing mechanism is always small, while that resulting from the pulling mechanism will always be large.

Size alone is perhaps not much of a criterion. It is, however, important to recollect that the herniæ of extreme size alter the possibilities of the hernial contents to such a marked degree, that the statement made above namely, that the sliding viscus is only one which has an incomplete peritoneal investment, requires a certain modification. Anatomically speaking, there is no viscus having a complete peritoneal investment, because that part of the viscus which gives entrance and exit to the nutrient vessels, etc., is always devoid of a peritoneal investment. I can, however, well imagine that in its gradual growth a hernia has reached such an enormous size, and has utilized for the formation of the sac so much of the parietal peritoneum, that paripassu it also involved the continuation of the parietal peritoneum, namely the mesentery (*e.g.*, the mesosigmoid). In a case of this nature it can be readily conceived that the mesosigmoid becomes unfolded, and in such a case, the sigmoid flexure may form the sliding viscus. Manifestly this must be an exceedingly rare occurrence, and as far as I can recollect I have never seen it. The nearest approach to such an occurrence and one which for aught I know may be unique in surgery, is a case in which I had the pleasure of assisting the late Dr. Arpad G. Gerster. The patient was a man in the fifth decade of life, who was afflicted with a huge inguinal hernia on the right side. It was of such a size that the patient supported it in an enormous bag suspended from the neck and shoulders. The hernia was evidently inoperable and I presume only the greatest pity for the afflicted individual, prevailed upon Doctor Gerster to attempt an operation. It is needless to even mention that the case did prove to be inoperable and the incision was closed. The hernial contents were interesting. In addition to other perfectly mobile viscera there was about one foot of the terminal part of the ileum adherent (sic) to the posterior surface of the sac, the mesentery of which was unfolded and utilized in the formation of the sac, in other words, in this extraordinary sized hernia even the small intestine became a sliding viscus.

The mechanism of the formation of a sliding hernia is to all intents and purposes akin to the picture which usually goes under the name of visceral ptosis. There is this difference, however, in visceral ptosis the ptosis occurs principally by a lengthening of the mesenteries of the viscera, and no matter how far it progresses the natural habitat of the viscera within the abdomen and pelvis is always maintained. On the other hand, in a sliding hernia the ptosis occurs in the attached part of the viscera and the habitat is changed from the abdomen to a hernia.

The mechanism of formation and pathological anatomy of a sliding hernia,

I repeat, has a most important bearing upon the question of treatment. The two important points to recollect are first, that the sliding intestine is at a lower level than it normally is, and second, that not only the intestine has slid down, but also the very important nutrient vessels. Were it not for the latter, the treatment of a sliding hernia would with slight variations not be different from any simple hernia.

The treatment that has been adopted till now has violated either all general surgical principles, or it has violated all those local surgical principles which we look upon as fundamental in the radical cure of a hernia. (1) One of the most ordinary mistakes made when operating a case of sliding hernia is the one I have mentioned, namely, failure to recognize the condition and regard the sliding intestine as adherent. What more natural than to attempt to "liberate" it? If an attempt is made to fully "liberate" the intestine the grave danger of devitalizing it is sure to ensue. (2) A second method of operating is to liberate the hernial sac as far as its attachment to the intestine permits, and then to ligate it in the best possible manner. This is followed by a reduction of the prolapsed intestine, a manœuvre which is manifestly impossible and which in turn is followed by an attempt at a radical plastic procedure. This operation violates two very important local principles in the radical treatment of a hernia, namely the high ligation of the sac, and the secure reduction of the hernial contents. These cases obviously recur and I have had occasion to reoperate quite a number of such cases. (3) A few years ago Hotchkiss devised a new principle in the treatment of these cases, which at first blush promised very much. As I understand Hotchkiss' method, it practically means to convert a loop of intestine, which normally is only partially covered by peritoneum, into one which is completely surrounded by peritoneum. When confronted with such a case Hotchkiss advises that the intestine be lifted up as far as it will permit; the outer part of the sac drops down and covers the nutrient vessels, whereupon the sac is fastened into place by a few interrupted stitches. A sort of a new mesentery is made which presumably permits reduction of the intestines. Regrettably this is not the case, because on careful analysis it will be found, that it is not so much the intestine which is a bar to a reduction, as the vessels which enter the gut posteriorly and mesially. It is true we have diminished the difficulty, but by no means obviated it. Add to this the difficulty, nay impossibility of closing the hernial sac, and we surely must arrive at the conclusion that the operation does not do all that is claimed for it. (4) The next procedure which has been recommended is to anchor the gut to the anterior or posterior abdominal wall to prevent it from again prolapsing into the hernia. I have performed this operation on a number of occasions, but have never been satisfied with it. (5) Finally it occurred to me, as very probably it has to others, to reproduce a normal condition by reversing the mechanism through which this particular hernia is formed. I can perhaps best illustrate what I mean by describing the operation as I would now carry it out.

If the hernia is of small size, and there is only a small sac present, it is

assumed that the hernia is one which has been produced by the pushing mechanism. The incision is merely lengthened a short distance in an upward and outward direction, until a liberal portion of the internal oblique is exposed. The fibres of this muscle as well as the transversalis muscle are now bluntly separated after the method of McBurney and the peritoneum opened. Traction upon the intraperitoneal continuation of the prolapsed intestine will soon replace it into its normal position whereupon it will be found that there is only a minute hernial sac present, practically only a slit in the peritoneum, which can be readily closed by a suture. In order to make assurance doubly sure, the replaced intestine is anchored by a few sutures to the posterior parietal peritoneum. The McBurney part of the operation is now closed, whereupon one of the radical operations (preferably the Andrews-Bassini method) is carried out upon the hernia.

If, on the other hand, the hernia is of larger size, it must be assumed that the mechanism which produced it is of the pulling variety. Hardly sufficient room is obtained in these cases by the short McBurney incision after convincing oneself of the exact status, it is best to abandon the original hernia incision altogether by a temporary packing. A fairly liberal vertical incision is now made on a level with the umbilicus. The small intestine and omentum are packed away towards the median line, exposing only the posterior parietal peritoneum and either the ascending or the descending colon, depending upon the side operated upon. This would be also an opportune moment for the skeptic to convince himself that contrary to the usually accepted view, it is not the sigmoid flexure, but the descending colon which is at fault. No matter how much difficulty there was in replacing the hernial contents before, simple traction upon the intraperitoneal portion of the intestine in a cephalad direction will reduce the prolapsed colon with the greatest ease. It is now held reduced and the posterior parietal peritoneum where it is reflected upon the intestine, is fastened onto the retroperitoneal tissues as near as possible into the normal position. On the outer side of the intestine this manœuvre is perfectly safe, and deep stitches can be taken. On the mesial side some caution is necessary to avoid the entering blood-vessels and the ureter. This wound is now closed in layers.

We now again turn our attention to the hernial incision. Much to our surprise we will find that the previous large hernial sac has disappeared almost entirely. There is no redundancy to speak of, whatever redundancy does exist is extirpated in the usual manner. The radical operation is then performed.

No frequent opportunity is given for performing this operation on account of the rarity of the condition. I do not know in how many instances I have tried it (the first dates back about ten years), but thus far no case has recurred. It appears to me rational and I venture to recommend it for a further trial.

SOME UNUSUAL NEW GROWTHS IN THE REGION OF THE INGUINAL AND THE FEMORAL CANALS

By J. Shelton Horsley, M.D.
of Richmond, Va.

The inguinal and the femoral canals derive their chief clinical significance from the fact that they are frequent sites of hernia. The inguinal canal in the male is of further interest because it transmits the sex organ. The migration of the testicle and its attachments through this canal during embryonic development apparently should afford opportunities for the deposit here of embryonic remnants that might later produce tumors.

Reasoning from analogy the occurrence of tumors of the inguinal canal from such a source would seem to be very probable, but as a matter of fact they are exceedingly rare. The thyroid gland, for instance, which arises between the two anlages for the tongue and then migrates in front of the larynx to its normal position in the adult over the upper portion of the trachea, often leaves in its route of travel remnants that are the source of either accessory thyroid glands or cysts or fistulas from the thyroglossal tract. The occurrence of ranula in the floor of the mouth as a result of the rearrangement of the muscles of the neck during embryonic life has been studied by Thompson, of Galveston (James E. Thompson, "The Relation between Ranula and Branchio-genetic Cysts," Annals of Surgery, vol. lxxii, No. 2, August, 1920, pp. 164–176). He seems to have shown that ranula, submaxillary cyst, and a deep cervical cyst that often communicates with ranula, are derived from the cervical sinus that has been carried by the muscles of the branchial arches and the hypoglossal segments from its original position in the neck during the migration of these muscles in early embryonic life. Cysts in the submaxillary and lingual regions he believes are carried upward by the muscles of the tongue which come from the hypoglossal group, belonging to the seventh, eighth and ninth body segments.

Fig. 1.—Drawing of the external appearance of the growth removed in Case I. (Natural size.) Note the cigar-shaped appearance with a distinct capsule.

In the inguinal canal of the female, cysts from remnants of the invagination of the peritoneum known as the diverticulum of Nuck are not infrequent, and may be classed as an example of new growths resulting from the persistence of embryonic tissue that normally disappears. Myomata also develop from the round ligament in the inguinal canal in women, but this has no embryologic significance, as the myoma merely springs from the muscular

tissue in the round ligament in the inguinal canal, just as it does from the muscular tissue in the uterus.

There is nothing more interesting in embryology than the formation of the genito-urinary system. From a phylogenetic view, it shows strikingly the process of evolution. The pronephros, which is the first stage in the development of the urinary organs, occurs on each side in very early embryonic life and is found when the embryo is from two to three millimetres long. It develops into tubules, glomeruli, and a duct, which constitute the permanent excretory system seen in the lowest animals, such as many of the worms. As the human embryo grows the pronephros entirely disappears, except for a small portion of the pronephric duct. The mesonephros, from which is derived the second set of urinary organs, begins to appear in embryos about three millimetres long immediately after the pronephros. This somewhat more elaborate system of urinary organs is also found in some of the lower animals as a permanent urinary system. In man much of the mesonephros disappears, but the mesonephric duct is responsible for the ureter with the pelvis and the straight collecting tubules of the kidney, the rest of the kidney being derived from the metanephros. From the mesonephric duct in the male also develops the conducting apparatus attached to the testicle—the epididymis,

FIG. 2.—Section of the growth shown in Fig. 1. (Natural size.) The numerous small cystic cavities with clear, shiny wall, are conspicuous. They were filled with a rather thin clear yellow fluid. The walls of the cysts are usually thin, though in some cysts the walls are thicker than in others.

FIG. 3.—Photomicrograph of tissue of tumor removed from Case I. There are two rather large cysts, portions of whose wall are included in the right and in the left of the picture. At the top of the photomicrograph is the margin of a smaller cyst which is lined with many layers of rather flat cells, and this portion of that cyst lining contains several giant cells. Near the centre of the picture (C) is a cyst lined with cells that at some points appear to be cubical and at others almost flat. A and B are smaller cystic cavities lined with cells resembling epithelium. There are also many apparently normal fat cells and some leucocytic infiltration. (X 90.)

the vas deferens, the ejaculatory duct and the seminal vesicles—while the testicle itself springs from the epithelium of the genital ridge of the mesonephros. In the male the structures derived from the mesonephric duct which persist in the rudimentary form and which may theoretically produce tumors later, are the appendage of the epididymis, the paradidymis and the aberrant ductules. The mesonephric structures surviving in the rudimentary form in the female—the epoöphoron, the paroöphoron and Gärtner's canals—often give origin to new growths.

The gubernaculum of the testicle, a cord which originally comes from the lower end of the mesonephros as the inguinal ligament, pierces the abdominal wall and is attached to the corium of the skin in the pubic region. It acts probably not so much by any intrinsic traction, but because the gubernaculum does not grow at the rate of the rest of the body, and as the development of the fœtus continues the testicle is gradually pulled down. With the invagination of the peritoneum, which is later normally obliterated and which forms the covering for the testicle, the descent of the testicle is made easier. In the female persistence of isolated portions of this invaginated peritoneum is responsible for the cysts of Nuck and in the male small cysts in the spermatic cord probably arising from this source are quite often seen.

FIG. 4.—A larger magnification of the preceding field. At the top of the photomicrograph can be seen the giant cells in the lining of the cyst. The cyst cavity (A) is lined with fairly regular cubical cells that resemble epithelium. In (B) the lining is more indistinct and the cells appear flatter. At the bottom of the photomicrograph is the upper margin of cavity (C) shown in the preceding photomicrograph. This, too, shows lining cells resembling epithelium. There are normal fat cells and considerable leucocytic infiltration. (X 180.)

Lipomas in the inguinal canal and along the spermatic cord are very common, and it has been suggested that they are one of the potential causes of hernia by preventing the structures of the inguinal canal from closing properly.

In the femoral canal there is no unusual embryologic interest, but the lymphatics and the lymph-nodes in this region may cause enlargements from inflammatory or malignant conditions that are sometimes confusing.

Besides the rather uncommon cysts of Nuck, and the frequently found cysts in the spermatic cord in the inguinal canal, I have had three cases that impressed the importance of bearing in mind the occurrence of unusual

growths in the regions of the inguinal or the femoral canal. In Case I the gross appearance of the growth as well as the histologic structure suggested the possibility of a cystic adenomatous tumor which I thought might have been derived from the remnants of the mesonephric duct. Further examination, however, showed that there was no such interesting possibility, the growth proving to be an unusual change in the histology of a lipoma.

CASE I.—Mr. J. M. H., age forty-five years, had been treated at St. Elizabeth's Hospital by my associate, Dr. A. I. Dodson, in January, 1924, for kidney colic resulting from a ureteral stone. After several cystoscopic manipulations the stone was passed and the patient seemed to be in good condition. He left the hospital on February 6, 1924. About the first of May the patient called the attention of Doctor Dodson to an enlargement in the right inguinal canal, the nature of which was somewhat puzzling. There were also some swelling of the right testicle and pain running down the right leg. There was no history of hernia. The growth was rather firm, somewhat tender on pressure, but not markedly so, and had evidently recently appeared. It was apparently attached to the cord, but was not adherent to the surrounding structures. It was cigar-shaped, and well defined. It was removed under local anæsthesia. It was attached quite firmly to the vascular structure of the cord and also to the vas deferens. By careful dissection it was freed from the vas deferens without injuring this duct. The attachments and vessels at each end of the growth were severed and the growth was removed.

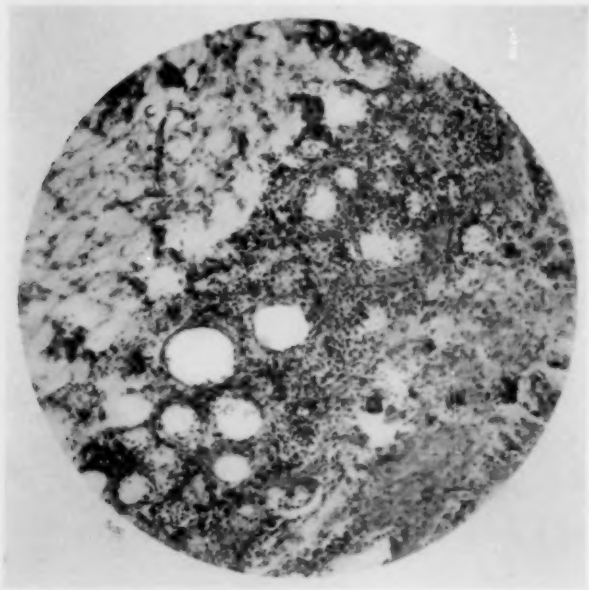

FIG. 5.—A section from the specimen removed in Case II. There are a number of small cyst-like cavities lined with epithelium-like cells resembling those shown in the two preceding photomicrographs. There are considerable leucocytic infiltration and some apparently normal fat cells and fibroblasts. There are no definite giant cells. (X 90.)

It was cigar-shaped and measured 7 by 2 by 2 cm. It was firm though somewhat elastic and gave on palpation the impression of a solid elastic growth or a very tense cyst. (Fig. 1.) The capsule was distinct and considerably congested. On section numerous small cysts were found throughout the growth. They were about one-third to one-half centimetre in diameter, and contained clear fluid. The cystic cavities were clear-cut and the walls appeared to be smooth and usually rather thin. (Fig. 2.) There was no evidence of any necrotic material. There was no cheesy substance.

Microscopic examination showed a very peculiar structure. Cysts were numerous. Some of them appeared to be lined with a cubical epithelium. In others the fibrous cyst wall supported no cells. Still other cyst walls were lined with irregular, rather flat, cells in which there were giant cells of the foreign body type. Throughout the section there were a few giant cells of the foreign body type in the tissue between the cyst walls. In many areas there was leukcocytic infiltration and in some places the tissue seemed

œdematous. The cysts varied in size, but almost all of them were spherical. There were no areas of necrosis. (Figs. 3 and 4.) The histologic structure was puzzling. It was thought the growth might arise from a remnant of the mesonephros or the mesonephric duct as the structure resembled somewhat cystic adenomatous tissue—a type of tissue that in the female may arise from remnants of the mesonephros.

A section was sent to Dr. A. C. Broders, of the Mayo Clinic, who at first suggested the possibility of there being a reaction from an injection of paraffin—a method employed in some of the advertised cures for hernia. As this patient, however, had never had a hernia and had never been injected this explanation was discarded. Doctor Broders thinks that the histologic appearance is the result of chronic inflammation in fatty tissue. On the whole this seems to be the most plausible explanation, though the cause of the inflammation and of this reaction in fatty tissue I do not know. Doctor Broder's letter, under date of June 18, 1924, says:

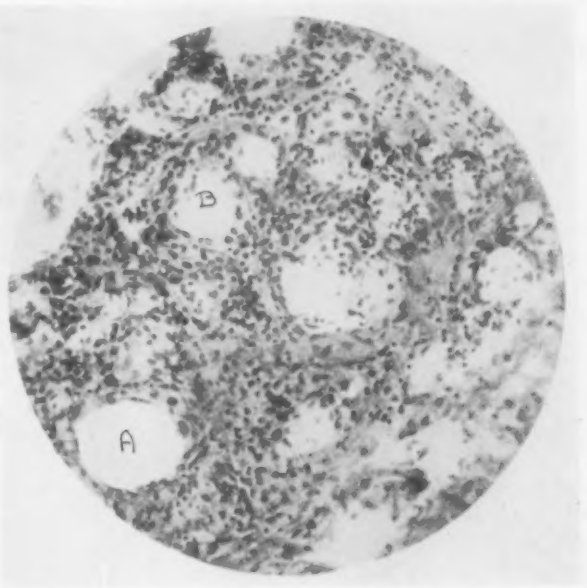

FIG. 6.—A higher magnification of the photomicrograph shown in Fig. 5. A and B show the cyst cavities with definite lining of cells resembling epithelial cells. (X 180.)

"……I have since made a thorough study of the tissue……I cannot see fit to change my opinion except to say that if he had not been injected with paraffin or some oily substance the microscopic picture is the result of chronic inflammation in fatty tissue. The cyst-like areas are lined with epitheloid cells and there are also a few scattered foreign-body giant cells. I have seen this microscopic picture of chronic inflammatory fat a number of times but the injection of an oily substance will also produce a similar picture……"

Fatty tumors adherent to the spermatic cord are often seen in operations for inguinal hernia. Doubtless a lipoma on the cord of this patient became inflamed and the reaction to the inflammation produced the unusual histologic appearance.

The patient reported on October 27, 1924. He is apparently entirely well. For some weeks after the operation there was moderate swelling of the testicle but the swelling has disappeared.

CASE II.—Mrs. C. E. H., age sixty-one years, was operated upon at St. Elizabeth's Hospital on December 21, 1921, for strangulated right femoral hernia. Under local anæsthesia the peritoneal cavity was opened above Poupart's ligament, the femoral canal was split and the small intestine which was caught in the femoral hernia was delivered. A loop of this intestine was gangrenous, and about 21 cm. were resected. Poupart's ligament was sutured to Cooper's ligament along the upper margin of the pubic bone and the conjoined tendon was sutured to Poupart's ligament. The patient made a satis-

factory immediate recovery, but there was suppuration in the wound. There was a small mass just below Poupart's ligament and to the outer side of the right femoral canal which the patient said had been there for many years. It was not observed at the time of operation, for the strangulated hernia obscured it.

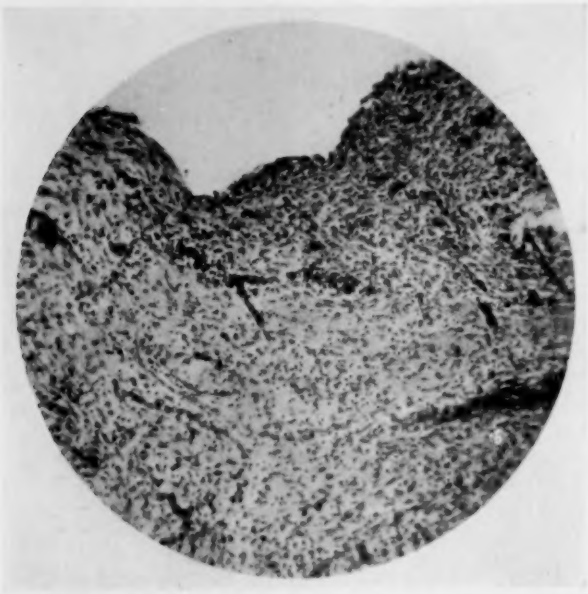

FIG. 7.—Photomicrograph of the wall of the cyst in Case II. The lining is of flat cells which constitute a definite layer, though it apparently has no basement membrane. (X 90.)

Under local anæsthesia this enlargement with some surrounding inflammatory tissue was removed on January 21, 1922.

The specimen consisting of a cyst and adjacent fat was oblong in shape and 7 cm. in its longest diameter. One side of this mass formed the wall of the suppurating cavity of the wound left by removing the sac of the femoral hernia, and was covered with necrotic material and a few sleazy granulations, beneath which was a marked inflammatory infiltration. This, however, did not communicate with the interior of the cystic cavity, though the inflammatory process involved the wall of the cavity very intimately. The cyst had been opened during the operation. It contained about 15 c.c. of clear straw-colored fluid which did not appear to be infected. The wall was smooth and there were no projections into the cyst cavity. The wall was about 1/5 cm. thick. Microscopic examination of the cyst wall and adjoining tissue showed inflammatory areas and small cyst-like cavities, some of which were lined with cubical or rather flat cells resembling those in the specimen from Case I. (Figs. 5 and 6.) The lining of the large cyst showed somewhat flat cells and underneath this lining was marked leucocytic infiltration. (Fig. 7.) These lining cells were quite regular and were probably endothelial cells. No giant cells were observed.

FIG. 8.—Drawing of specimen removed from Case III. (Natural size.) The cyst wall is regular and definite, and surrounded by adherent fat that appears normal. Portions of the cyst wall are trabeculated. In other areas there are papillomatous-like projections of a considerably darker color than the lining of the rest of the wall. Most of the lining membrane is smooth and glistening.

In the femoral canal the adjacent lymph-nodes and the large lymph channels that drain the leg with the lymph-nodes in the inguinal region may afford the starting point for a growth that sometimes is confusing when considering the diagnosis of femoral hernia.

CASE III.—Mrs. J. I. J., age forty-two years, entered St. Elizabeth's Hospital, January 13, 1924. The examination was practically negative except for a firm slightly movable mass just below Poupart's ligament in the region of the left femoral canal. It was quite tense and appeared to be an incarcerated femoral hernia. There were no symptoms of intestinal obstruction. About eight weeks previously she had noticed this lump. Since that time it had increased in size. The patient never wore a truss. The growth had not been painful except for occasional shooting pains. She was operated upon on January 14, 1924. There was some relaxation in the left inguinal canal, which was repaired. The enlargement was exposed and was found covered with fat and quite firm. It was superficial to the femoral canal. The femoral canal was not enlarged. Posteriorly the growth was very closely attached to the terminal portion of the saphenous vein.

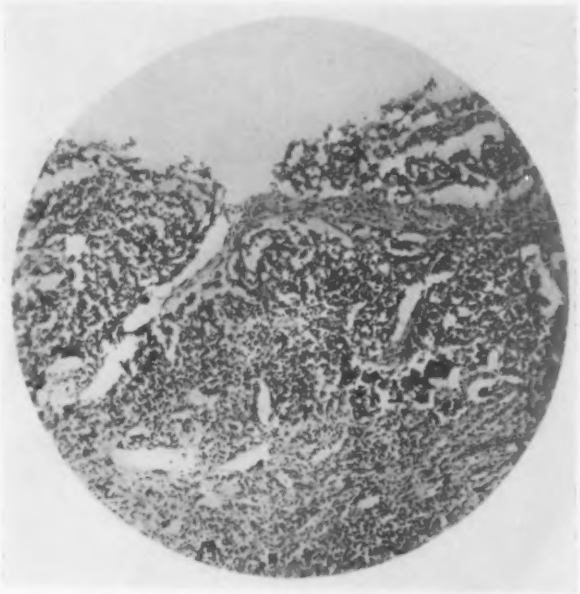

FIG. 9.—Photomicrograph of tissue from the papillomatous-like projections into the cyst wall of the specimen shown in Fig. 8. There are numerous lymph spaces and many regular round cells. The general appearance of the structure resembles lymphangiomatous tissue. (X 90.)

The growth when removed measured 3 by 4 by 3 cm. and consisted of a cystic tumor surrounded by fat. On incision there was a well marked cyst which contained thin opaque fluid under pressure. The fluid was ocher yellow in color. There were soft masses which occupied only a small area of the sac. These areas were sharply marked and formed papillomatous-like projections into the cyst cavity. At other regions the cyst wall was shiny, though in some areas trabeculated. (Fig. 8.) Microscopic examination of the papillomatous projections into the cyst showed much loose lymphoid-like material, apparently lymphangiomatous. There were many spaces of loose reticular tissue in which there was a number of small round cells well differentiated. In other areas there was a distinct inflammatory reaction with fibrous tissue infiltrated with leucocytes. It seems to be a lymphocele with lymphangiomatous tissue. (Figs. 9 and 10.)

In the first two cases there was evidently an inflammatory agent which produced an unusual reaction in the fat. Lee and Adair, of New York, have done very interesting work in calling attention to traumatic fat necrosis of the female breast. (Lee, Burton J., and Adair, Frank E.: Traumatic Fat Necrosis of the Female Breast and Its Differentiation from Carcinoma, ANNALS OF SURGERY, August, 1920, vol. lxxii, pp. 188–195. A further Report on Traumatic Fat Necrosis of the Female Breast and its Differentia-

tion from Carcinoma, Surg., Gyn. and Obs., vol. xxxiv, April, 1922, pp. 521–531. Traumatic Fat Necrosis of the Female Breast, ANNALS OF SURGERY, November, 1924, vol. lxxx, pp. 670–691.) Cohen (Cohen, I.: Traumatic Fat Necrosis of the Breast, J. A. M. A., 1923, vol. lxxx, p. 770) and Farr (Farr, C. E.: Ischæmic Fat Necrosis, ANNALS OF SURGERY, 1923, vol. lxxvii, pp. 513–523) have recently written on this subject, and Farr has reported experimental work in which he produced similar lesions in the fat of pigs.

Dr. James Ewing, who examined the specimens removed by Lee and Adair, says that there are many different microscopic pictures of traumatic fat necrosis, and it varies considerably in different stages, but, he says: "Usually the microscopic section furnishes a correct interpretation at once from the presence of much cellular overgrowth, fibroblasts mingled with lymphocytes, empty spaces once filled with fluid fat (oil cysts), formation of many phagocytic giant cells, and wide areas of proliferating fat cells."

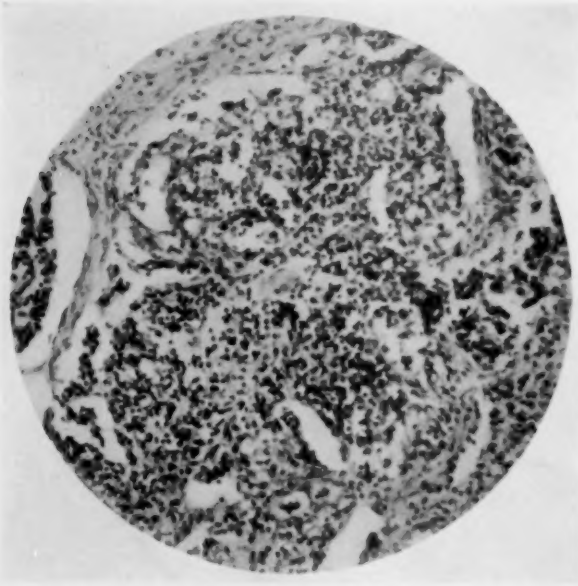

FIG. 10.—A higher magnification of the tissue shown in the preceding figure. The general structure of lymphangiomatous tissue, lymph spaces and numerous lymphocytes and trabeculæ are shown. (X 180.)

The specimen from the first case showed no evidence of necrosis. The interesting feature was the number of cysts, many of which were lined with cells resembling cubical epithelium. Giant cells mentoned by Ewing also were present both in the tissue and among the cells lining the cystic cavities.

Apparently the reaction of the fat to some inflammatory agent in the first two cases is of the same general nature as in traumatic fat necrosis, but there are differences in the absence of necrotic areas and in the presence of many small spherical cysts lined with cubical or flat cells. The giant cells in the first case and the leucocytic infiltration and fat cells in both cases have been emphasized by Ewing as appearing in traumatic fat necrosis. In a few of the photomicrographs published in the articles of Lee and Adair there are one or more cyst-like cavities with a lining of cells somewhat resembling those found in the cases here reported, but this seems to be exceptional, whereas in these cases it was the rule.

PELVIC ACTINOMYCOSIS

A STUDY OF FIVE CONSECUTIVE CASES SUCCESSFULLY TREATED BY OPERATION

By Walter M. Brickner, M.D.

of New York, N. Y.

FROM THE SURGICAL SERVICES OF BASE HOSPITAL 3, A.E.F., THE MOUNT SINAI AND THE BROAD STREET HOSPITALS, NEW YORK

Case I.*—Private James G., United States Army, aged twenty-two, was billeted at Gondricourt when, on March 25, 1918, he felt pain in his left groin and testicle and noticed a red spot just above his left hip. At the camp hospital he was strapped with adhesive plaster and returned to duty. The spot becoming larger, the pain increasing, and a swelling appearing in the groin, he was on April 1 sent, with a diagnosis of bubo, to a base hospital. There he was put to bed, wet dressings were applied to the hip lesion, and an X-ray picture was made. On April 11 he was operated upon for a varicocele that had developed on the left side, although the records stated that he then had a large mass in the left groin! The wound from this operation apparently healed normally and the varicocele disappeared. On April 30 another X-ray picture was made. Pus discharging from the lesion near the left hip was examined, and a small incision was made to permit its freer escape. At that time the soldier was losing weight and strength very fast. It was thought that he had tuberculosis of the hip and on May 21 he was discharged to another base hospital with that diagnosis. On June 11 he was transferred, with the same diagnosis, to Base Hospital 3. There on June 16 he first came under my observation as a member of the Disability Board. He was weak, pale, emaciated (weighing 95 pounds), scarcely able to stand. His pulse was rapid and his temperature elevated. He had a small discharging sinus above the left great trochanter, a purplish, inflammatory, hard plaque, larger than a silver dollar, in the skin of the left lumbar region, and a mass in the iliac region above Poupart's ligament. The appearance of the skin involvement and the presence of yellow bodies in the pus from the sinus made both Major H. L. Celler (chief of the medical service and a member of the board) and myself feel sure that the soldier's ailment was actinomycosis, and this diagnosis was confirmed by Lieut. B. S. Denzer upon finding mycelia and clubbed organisms in the pus. With that diagnosis we would have done our full military duty if we had marked the soldier "Class D" and sent him back to the United States; but, even if he survived the voyage, it would have involved a delay of several weeks before he could get radical treatment, and he would have lost the apparently small chance of survival that he might still have. I therefore decided to give him that chance by immediate operation. Röntgenograms showed a limited involvement of the external surface of the ilium, but none of the hip or the lungs.

At the *operation*, June 18, 1918, I laid open the sinus down to the ilium and cleaned out the involved portion of the bone. The incision was then carried up into the loin and the inflamed skin area was excised widely just as one would a malignant growth. Another incision was made along Poupart's ligament, and a large retroperitoneal, foul-smelling actinomycotic abscess was evacuated. The external iliac lymph-nodes were extensively involved and much enlarged. Several were removed. Others, extending up along and too densely adherent to the external iliac artery to warrant dissection therefrom, were split open. The pus and broken down tissue in these glands had the same appearance as that in the abscess. Several sinuses were found extending down the thigh under the fascia

* Published with authority of the Surgeon General of the Army.

lata, all containing pus of the same appearance. These were laid open. Drainage tubes and iodinized gauze packs were inserted throughout the huge wounds. This brief statement of the operation gives but an inadequate idea of how formidable and extensive the procedure was.

The patient was kept continuously in the open air and nourished as well as was possible. Every pocket and angle of the huge wounds were irrigated at first twice, then once, daily with iodine solution—sometimes a diluted tincture but usually Lugol's solution in 1 to 3 per cent. strength. In addition, increasingly large doses of potassium iodide were administered. For a long period the patient received 700 grains of potas-

FIG. 1.—Case I. James G. Extensive wound of outer thigh and loin about a month after first operation, 1918. Drainage tube seen projecting from the large wound in the groin.

sium iodide (dissolved tablets) daily without any discomfort whatever! On July 11 I incised and drained a fresh skin pocket above the groin. Two intravenous injections of salvarsan (.45 and .60) and two X-ray exposures within the next fortnight had no noticeable influence upon the wounds. (Fig. 1 shows one of these—outer thigh and loin—as it appeared about a month after the operation.) The (iodine) irrigations, however, appeared to supplement the free drainage in controlling the suppuration and there was steady improvement in the soldier's general condition and gradual healing. About the middle of the next month (August) this healing had so far progressed that the patient became ambulant, and by the end of the month, when I was temporarily transferred to duty at Evacuation Hospital 8, it was nearly complete. Before my departure I warned the officer who was to take my place in charge of the surgical service and the soldier himself that he should not be discharged until all wounds had been entirely healed for at least two months. On September 13, however, apparently quite healed, he prevailed upon my successor, hard pressed for bed space, to release him. When he reached Brest the groin was again discharging pus and on the voyage to the United States he was very ill.

In this country there were repeated recurrences of abscesses in the scars of the groin and lumbar, with intervening free periods. When I saw him again, in March, 1919, he was an ambulant patient at U. S. General Hospital 3, Colonia, N. J., where, upon my suggestion, Major Albee, in charge, was kind enough to direct the treatment of these abscesses by incision, iodine swabbing, X-ray exposures and iodide internally. In

June a rather large abscess had formed but it healed after incision and irrigation. On October 8, 1919, the patient was transferred to U. S. General Hospital 2, Fort McHenry, where he continued to have pustular recurrences in the groin or loin. On April 1, 1920, he was finally discharged from the hospital and the army, and he then came again under my care with a "pustule" in the left groin and, a few days later, another just below the level of the crest of the left ilium. With a fine probe it was found that these "pustules" were the openings of long slender sinuses. That in the groin led deep down in the pelvis, towards the obturator foramen; no bone was felt and there was no discharge. The posterior sinus, discharging slightly, appeared to lead upward into the back a short distance. For about six weeks these sinuses were vigorously treated by iodine injections, and potassium iodide by mouth, but they failed to heal and, accordingly, I had the patient admitted to Mount Sinai Hospital, New York (service of Doctor Moschcowitz) where on May 25, 1920, I submitted him to a second extensive and formidable operation:

Both sinuses were first stained by injecting a solution of methylene blue. The sinus in the groin was found to lead down through the remnant of Poupart's ligament, just external to the femoral vessels, deeply (about 10 centimetres) into the pelvis, retroperitoneally. It was completely excised with the surrounding column of scar and inflammatory tissue. At a depth of about 5 cm. a single drop of pus was found, lying perhaps in a remnant of gland tissue. At the bottom of the sinus was found only a small fragment of blue-stained soft tissue (gland remnant?), which was also removed. The dissection was carried down near to the pubic bone; but muscle tissue intervened and there was, therefore, no evidence of bone involvement.

A longitudinal incision was then made circumcizing the posterior sinus, which was dissected. It was found to lead up about 2.5 cm. above the crest of the ilium, and then to dip down inside the pelvis to the deep groin! It was easy to follow with the blue stain and a probe. The incision in the groin was then connected with the incision posteriorly by dividing the abdominal muscles above the crest and spines of the ilium, and reflecting the peritoneum and viscera, just as in extirpation of the lower ureter. The sinus was thus easily exposed, running retroperitoneally upon the psoas-iliacus, almost parallel with the ureter, crossing the anterior crural nerve. It terminated at the same spot as the sinus in the groin. Nowhere was there any bone involvement, and no trace of the originally much involved iliac glands was found (except, perhaps, the small fragment of tissue adherent to the first sinus, above mentioned). The upper two-thirds of the second, longer, sinus, were dense enough to permit of extirpation. The lower portion practically disappeared as a structure when it was divided. The external iliac artery, covered by dense inflammatory tissue, was exposed.

A branch of the tract was found extending laterally, into the lumbar muscles, about 3 cm. It was excised, the cavity iodinized, and a tube inserted for subsequent iodinization—likewise a gauze drain. After thoroughly iodinizing the rest of the large wound, a second tube was placed in the pelvis in the path of the longer sinus, and a third tube in the path of the groin sinus, both fastened with stitches at the skin for iodine injections. Temporary gauze drains also inserted. Muscles then sutured, in part, with chromicized catgut. (The muscle attachments and Poupart's ligament in the inner two-thirds of the groin were found replaced by scar tissue, but there was no hernia.) The patient stood the operation excellently, most of the time having only nitrous oxide and oxygen. No shock; very little loss of blood. The sinus tract was reported, histologically, "inflamed fibro-muscular tissue."

For several days when there was profuse suppuration in the anterior wound, dakinization was tried and then abandoned in favor of 3 per cent. aqueous iodine solution. Copper sulphate, gr. ¼ t. i. d., was administered for a few days only because not well tolerated, although salol-coated. Potassium iodide in increasing doses, beginning with 40 grains t. i. d., was also administered more or less continuously, remitting when gastric symptoms appeared. At no time were ray fungi found in the pus.

On July 1, the patient left the hospital with the wound entirely healed except a small sinus in the groin. Although scarcely discharging, this failed to close in spite of injections of iodine, potassium iodide and copper sulphate solutions, and of other efforts during the next three months. In October, as a measure of despair, I injected a 50 per cent. solution of potassium iodide. This was promptly followed by a violent reaction: The groin became tumefied and purplish red, there were fever, pain and prostration. I had the patient readmitted to the hospital, October 16, 1920, expecting that a third operation would be necessary. The swelling, redness and fever (102°) all gradually subsided, however, and on November 16 the patient was again discharged with only a small sinus in the groin. One week later this sinus closed and the sinus over the iliac crest reopened. On December 9 this sinus also closed and neither of them has ever reappeared.

FIG. 2.—Case I. James G. Photograph March, 1919.

In the four years that have since elapsed, I have seen this patient often. He has not at any time presented any suggestion of a recurrence of the disease. The extensive scars are firm, clean, pliable. (Fig. 2.) On straining there is slight bulging where the lower abdominal musculature is deficient, but this causes no discomfort and is not disabling in the man's occupation. He is fat, well and strong, has married and become a father. It is of interest to note here that at no time between March, 1919, and the definitive healing in December, 1920, were any yellow bodies observed by me in the pus. During the nearly three years that the disease had been manifest the patient had been taking large doses of potassium iodide for long periods. Copper sulphate medication had also been tried several times, but was never tolerated more than a few days.

CASE II.—Theodore F., was ten years old when on May 11, 1910, he was admitted to the surgical service of Dr. A. G. Gerster at Mount Sinai Hospital. For two months he had had pain on the left side of the abdomen and, more recently, also in the right hypochondrium. On the left side of the abdomen was felt a large nodular mass extending above to the costal border, below nearly to the crest of the ilium and mesially nearly to the umbilicus. It was *not tender*. The liver edge was felt about an inch below the costal border.

At operation (Doctor Gerster) this mass was found to be in the abdominal wall, of cartilaginous consistency, and composed of several hazelnut-sized nodules. The stomach and descending colon were adherent to the mass. One of the nodules, cut into, was soft

in its centre, where it contained yellow particles; smears and cultures therefrom were negative, however. The wound was closed by sutures and was healed when the boy was discharged June 7. He was readmitted November 8, 1910, for the treatment of an abscess that had formed on the right side. A tender mass was then felt in the right hypochondrium extending into the flank. Through an incision in the lumbar region (Doctor Gerster) pus and "actinomycotic necrotic tissue" were evacuated from within the muscles and several pockets were swabbed out with tincture of iodine. Actino-

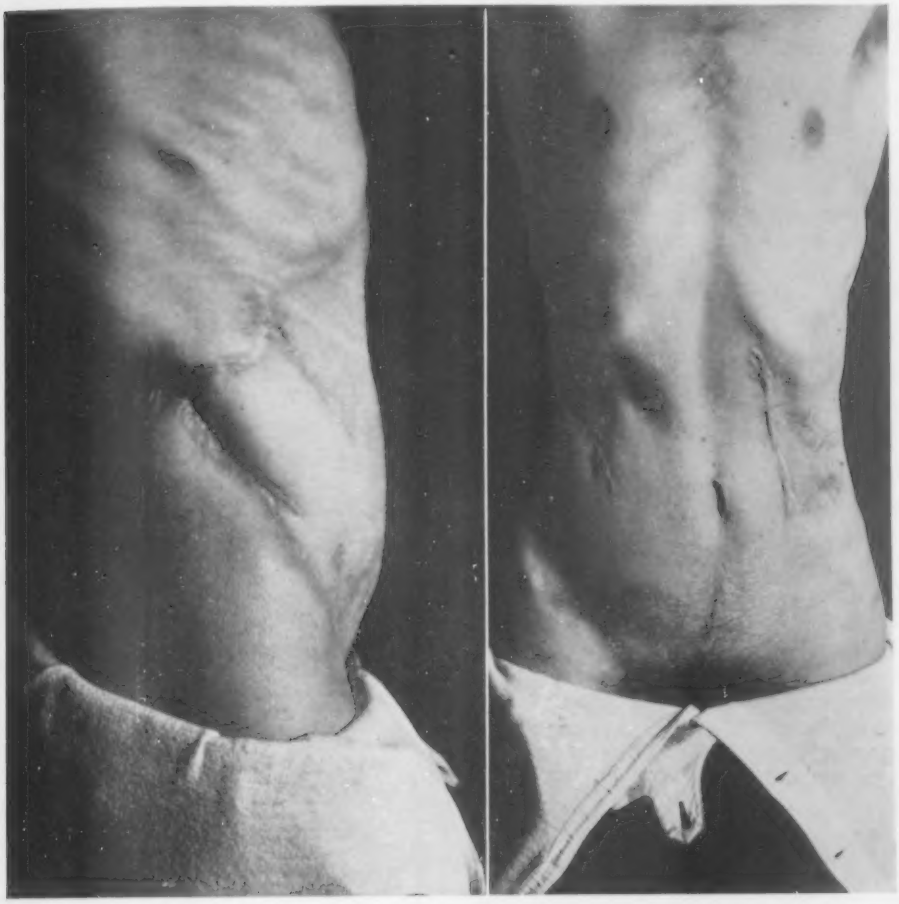

FIG. 3.—Case II. Theodore F. Photograph 1924—three years after definitive healing.

mycetes were found in the pus. The wound closed gradually and the boy was discharged from the hospital in a month.

During the ten succeeding years his health remained fairly good, but every few weeks, following a period of pain and malaise, an abscess would appear in the scar on the right side, discharge for a time and then heal. In 1916 he was operated upon for one of these abscesses by Doctor Blank at Sydenham Hospital, New York.

On July 20, 1920, the patient, then twenty years old, was admitted to the medical service (Doctor Manges) of the hospital with a discharging sinus in the right lumbar scar. The coarse scar on the left side (Fig. 3) had remained free from trouble and the large mass, explored by Doctor Gerster ten years previously, had *completely disappeared*. The sinus ran back to the loin just beyond the tip of the right twelfth rib. The purulent

discharge became more profuse, but no granules were seen in it. Nor were actinomycetes found in smears from this pus or in the stools. Injected with sodium bromide the sinus was but poorly shown in a röntgenogram. X-ray examination of the chest was negative. Potassium iodide was administered in doses increasing to 90 grains t. i. d.

The patient came under my care August 13 by transfer to the surgical service of Doctor Moschcowitz. At that time involvement of the liver was suspected. Characteristic yellow bodies were found in the pus a few days later. After an ineffectual trial of potassium iodide and copper sulphate medication I submitted him to *operation*, August 27:

After injecting a staining solution of methylene blue into the sinus it was dissected by a longitudinal incision extending through the abdominal muscles to the back. At the centre of this incision a transverse incision was made, crossing the tip of the twelfth rib, and the back muscles were freely divided, exposing a dilated portion of the tract and the parietal peritoneum. By means of probe and blue stain a narrow extension was located, beyond the dilated portion, running posteriorly between the peritoneum and the deep muscles to the spine, but no bare bone was felt. It was thought unwise to cut through the full thickness of these deep muscles to extirpate this short extension. A tube drain was therefore stitched into it. The expanded portion of the tract was extirpated, partly by excision, partly by curetting, and a tube was stitched into this cavity. Partial wound closure by sutures.

Local treatment by Lugol's solution (half strength) injected daily. Copper sulphate, gr. ¼–½ t. i. d., in salol coating, administered intermittently after August 11, was discontinued September 17.

On September 22 the sinus reopened in the anterior portion of the wound, but soon closed again. The posterior sinus was injected on alternate days with gentian violet and with diluted Lugol's solutions, respectively. On October 15 bismuth paste was injected for X-ray examination. This showed the sinus running from the opening in the lumbar region to the site of the right lateral process of the second lumbar vertebra.

October 22, 1920, second *operation* (Brickner): Methylene blue solution injected. An incision was made posteriorly from the mouth of the sinus and carried down through all the back muscles and across the psoas to the spine itself. The vertebra was felt but again no bare bone was found. An extension of the tract upward along the spine about 4 cm. was laid open. Anteriorly the wound had healed solidly. Opening into the tract was a cavity extending down into the pelvis fully 25 cm. from which, when this opening was dilated, pus escaped. The cavity was laid open by free retroperitoneal incision carried down into the pelvis, with caution to avoid the ilio-hypogastric nerve. The abscess was found to lie in the body of the psoas, and this muscle was split boldly open until the bottom of the cavity was exposed. A large amount of "dirty-looking" pus, granulations and characteristic broken-down tissue were, respectively, evacuated and removed with scalpel and curette. (The methylene blue had entered the pelvic abscess, but not the bismuth.) The peritoneum was not opened. The right kidney, partly exposed and palpated, appeared normal. The wound was washed out with ether and then with Lugol's solution, half strength. One tube was inserted alongside the spine, and two were laid into the pelvic cavity. The wound was lightly packed with gauze and left wide open.

Post-operative treatment was, at various times, by dakinization and by iodine irrigations, by potassium iodide (30 grains t. i. d.) and, for a short period, by copper sulphate, internally. The large wound was soon granulating satisfactorily and free from suppuration. On January 13, 1921, the patient left the hospital with only the lower angle still open. This also was healed by February, 1921, since which time, now nearly four years ago, the young man, whom I see at fairly regular intervals, has had no recurrence of his malady, is doing heavy work and feels well. He has no hernia.

CASE III.—Gertrude G., wife of a storekeeper in North Dakota, was eighteen years old when, in December, 1918, soon after her second childbirth and what was said to be

an attack of "flu," she developed a pelvic abscess which was drained *per vaginam*. A month later laparotomy was performed through a median hypogastric incision and the appendix and left ovary were removed. The wound drained for several months but finally healed. Soon after, however, (in the spring of 1920) fever appeared and a mass developed to the left of the incision. This mass was excised and examined histologically, but its character was not determined. The wound never entirely healed. There persisted a sinus discharging pus abdominally and another discharging into the vagina. The patient went to the Mayo Clinic in February, 1921, where she remained thirteen weeks. There the diagnosis of actinomycosis was established and she was treated by sodium iodide intravenously, potassium iodide by mouth, three radium and three X-ray exposures, all without material improvement. (This is one of the fourteen cases of actinomycosis of the gastro-intestinal tract reported from the Mayo Clinic by Brogden.[1]) In September, 1921, she entered Mount Sinai Hospital and came under my care on the service of Doctor Moschcowitz. She was in very poor condition, weighing less than 110 pounds and correspondingly thin; hæmoglobin 60 per cent. Pus was discharging from a sinus in the mid-hypogastric region and also into the scarred posterior fornix vaginæ. It was determined by injection of a dye that these two sinuses communicated. No granules and no mycelia were found in the pus then, nor have they been at any time since. The lower abdomen bore a large, broad, thin scar in the midline and the intestines lay just under the skin. The pudendal hair had disappeared (radiation) and the patient had not menstruated for many months. The uterus was of normal size but appeared to be somewhat fixed; the os was gaping but there was no uterine discharge. Urine negative.

September 27, 1921: *Operation* (Brickner). Gas and ether. Long median hypogastric incision through the old scar. The abdominal wall for several inches on each side was very thin (no rectus muscle), but the transversalis fascia appeared to be intact—no true hernia.

The abdominal sinus extended down as a thick tube to a mass deep in the right iliac fossa which, at first, appeared to be the cæcum. The latter, however, proved to be uninvolved and, indeed, the intestines were found entirely normal and free from adhesions, as was also the omentum. The mass was the size of a small peach, probably almost entirely inflammatory, and riddled with numerous yellow foci of suppuration, with, on its surface, a shell-like portion of what may have been the remnant of the right ovary. The removal of this mass left a raw area at its base (posterior parietal peritoneum). The mass had to be dissected from the fundus of the bladder, to which it was attached. In the thickened wall of the bladder at this site was another small abscess, the cavity of which was curetted and iodinized, after trimming away its roof. The sinus itself was excised *en bloc*. The pus surrounding and escaping from the mass was moderately thick, very yellow, inodorous; no granules noted. After removing the mass, pus was seen escaping from a narrow tract in the outer wall of the cavity in which it had lain. This sinus extended downward and outward about 8 cm. through the peritoneum and the muscles and other pelvic tissues to the bone (ilium ?). A probe was passed into it; then an incision was made in the right inguinal region and the finger passed in deep until the probe was felt. The sinus was dilated with forceps and a small tube was inserted into it from within the pelvis and brought out through the inguinal wound. The tube was left long for iodinizations, and iodoform-ether was injected into it. The raw area left beneath the removed mass was curetted and repeatedly rubbed and flooded with iodoform-ether. An extension of the process was found as a small pocket of pus pointing through the peritoneum, towards the sacrum. It was curetted and iodinized. The uterus was found small and uninvaded. Left tube and ovary missing. Right tube missing. Right ovary (remnant) probably in the inflammatory mass. The opening into the vagina, a small one, was split wide and two large iodoformized gauze packings, tamponing the infected (abscess) cavity, were led out into the vagina. The abdominal wall was closed in two layers, without drainage, and the inguinal wound was sutured in layers about the tube.

The specimen removed was reported from the pathological department by Doctor Aschner as "a mass of tissue about 5 cm. in diameter, source not determinable. It shows on section numerous pin-head size yellow areas. Microscopy: inflammatory tissue. Here and there typical [radiating] colonies of actinomycosis."

The patient's hospital history for the nine months following this operation is a record of progressive extension of the process, profuse suppuration, protracted febrile periods, increasing emaciation (to 85 pounds) and anæmia; and of desperate, and ultimately successful, efforts to control the disease by active local antiseptic treatment, fresh air, forced feeding, internal medication, blood transfusions and numerous extensive operations.

October 1, 1921: Pus discharging from lower portion of abdominal wound.

October 4: *Operation* (Brickner). Under N_2O wound opened. Intestines, uterus and pelvic wall found covered with a pyogenic membrane. Iodinized. Gauze packings.

October 7: Pyogenic membrane disappearing. Wound filled with 1 per cent. aqueous iodine solution, to be repeated daily.

October 13: Hæmoglobin 32 per cent. Transfusion of 500 c.c. of citrated blood.

October 17: For the first time no retention of pus. Abdominal wound washed with peroxide of hydrogen and with 1 per cent. iodine solution. Vaginal drainage has been discontinued. Patient is taking 45 grains of potassium iodide t.i.d.

October 27: An induration developing on the right side of the pelvis (iliac region) is softening and discharging creamy pus abundantly into the pelvic (hypogastric) wound cavity, which is granulating and contracting. A probe passed into the latter enters this mass on the right side. Fever. Wound in groin has closed.

November 1: *Operation* (Brickner). N_2O. Counter-incision in right iliac region.

November 12: Hypogastric wound contracting. Profuse suppuration from right iliac wound. Bare bone felt in its depth. Right buttock is increasing in size, but not reddened; pain and tenderness in region of tuber ischii. Emaciating.

November 15: Blood transfusion, 450 c.c.

November 25: Transferred to open-air ward on roof.

December 2: *Operation* (Brickner). N_2O and O. Incision of right buttock and evacuation of abscess. Intra- and extra-pelvic drainage established. Revision of hypogastric and iliac wounds.

During succeeding weeks the buttock, iliac and hypogastric tracts were irrigated every three hours with 1–1000 potassium permanganate, followed by 1 to 1.5 per cent. iodine solutions. For a time methylene blue and gentian violet solutions were used. Siphon drainage was also attempted with meagre success. Röntgenograms at intervals failed to show evidence of bone involvement.

February 16, 1922: General condition improved but suppuration increasing from two sinuses in buttock and from abdominal wound. Sodium iodide, gr. 60–90, t.i.d. Pain and tenderness in right ilio-lumbar region.

February 17: *Operation* (Brickner). N_2O. Methylene blue injected into tracts. Incision through tender area above crest of ilium. Thorough exploration through psoas to peritoneum and down into pelvis, but neither lesion nor blue stain was found. Closure by sutures. Right buttock then freely bisected by an incision carried upward from the opening of the sinus, dividing the glutei boldly. In the region of the sacro-sciatic foramen a puddle of pus, stained blue, was found communicating through one of the sacro-sciatic foramina with the abscess in the pelvis discharging anteriorly. Irrigation through and through. A branching tract close to the anus laid open. Tracts curetted. Tube through buttock wound into the foramen. Light gauze packing.

March 17: *Operation* (Brickner). N_2O and O. Probe in abdominal sinus passes beneath internal iliac vessels to inner surface of right ilium. Original incision in right groin extended upward along pelvic brim and crest of ilium, avoiding external cutaneous nerve. Iliacus muscle dissected up from the bone and, with the psoas, retracted mesially exposing the flare of the ilium. Close to the sacro-iliac joint an area of eroded bone

thus exposed. Here tip of probe in abdominal sinus was seen, covered only by the raised periosteum, which was cut through. Two eroded areas in bone, containing pus and granulations gouged out, and porous-appearing cortex chiselled away. Communication with abdominal sinus enlarged. Iodinization. Tube drains.

March 21: Condition better than at any time in hospital. Weight increasing slowly, anæmia improving.

March 31: *Operation* (Brickner). N_2O and O. Revision of wounds to provide freer abdominal drainage. The sinus appears to lead only to bone, which was curetted through the iliac approach, as above.

April 15: As a result of the last operation or of subsequent dressings, there has developed a fecal fistula now discharging freely through the abdominal wound.

May 2: *Operation* (Brickner). Enterorrhaphy. Incision of skin. Affected loop of gut gently liberated sufficiently to allow introduction of sutures, without exposing general peritoneal cavity. Wound along iliac crest suppurating; it also leads down to an opening through the thickness of the ilium made in the preceding operation.

After the last operation the intestinal leakage ceased definitively. The wounds, irrigated at various times with gentian violet, Dakin's and iodine solutions, gradually ceased to suppurate, and the patient's condition continued to improve.

On June 13, 1922, when she left the hospital, all wounds and tracts were closed, except the original hypogastric sinus, discharging slightly.

FIG. 4.—Case III. Gertrude G. Photograph 1924.

I have kept this patient under observation since then. She improved steadily in health and strength. She now weighs over 140 pounds, looks very well and does her housework without fatigue. The pudendal hair has returned. The pelvic sinus remains. It passes from the centre of the hypogastric scar, directly back among the coils of intestine, apparently to the ilium or sacrum, although no bare bone can be felt with a probe. The tract is slender and can hold but a dram or two of fluid. It discharges but a small amount of sero-pus, and the opening in the skin has a tendency to close. To prevent this the patient wears in this opening a short bit of Carrel size rubber tubing, through which she washes out the tract daily.

The sinus causes her little inconvenience. Therefore, in view of her excellent health, I have considered it unwise to submit her to another formidable operation in an effort to close this tract until a possible recrudescence of the disease may make this necessary.

In January, 1924, she had pain and moderate fever for a few days, but they subsided promptly when a small quantity of retained pus (free of mycelia) was washed from the depth of the sinus.

At this writing (November, 1924) this woman has as remnants of her long and desperate illness only the intestinal bulging in her lower abdomen, extensive scarring (Figs. 4 and 5), amenorrhœa and sterility, and this sinus, which has not thus far resumed the appearance or the discharge characteristic of actinomycosis.

CASE IV.—Everett S. was thirty-seven years old when admitted to Mount Sinai Hospital, July 27, 1922. He was born on a farm but had lived in cities for thirty years; and he did not handle cattle, grasses or grains during those years. Since he was twenty-one years old he had been continuously employed in the paint and varnish business.

FIG. 5.—Case III. Gertrude G. Photograph 1924.

At the age of eighteen he was shot with a pistol, the bullet entering the right iliac and lodging in the right lumbar region. There, a month later, a large abscess formed; about a pint of pus was evacuated by incision, the bullet was removed and the wound healed after several weeks. About two years later he developed a severe diarrhœa (ten to fifteen stools daily), which persisted for ten years and then ceased entirely.

On September 25, 1921, he became ill with fever, vomiting, diarrhœa and increasing "soreness" in the right iliac region. On October 11 he entered St. Catherine's Hospital, Brooklyn, where, eight days later, Doctor Jennings incised an abscess in the right iliolumbar region. Subsequently a swelling appeared more posteriorly, near the crest of the right ilium, which was drained by incision November 20. When discharged from the hospital, December 13, pus was escaping from both sites and his general condition was not improved.

During the next six months these two "abscesses" intermittently discharged and closed. In July, 1922, he consulted Dr. A. A. Berg, who expressed the opinion—probably quite correct, as later events proved—that these persistent sinuses were due to a diseased appendix, and who sent the man into his service at the Mount Sinai Hospital for its removal.

The patient was somewhat emaciated. The wound in the right iliac region was healed, but there was a sinus opening a little below the iliac crest posteriorly which appeared to lead deeply forward just over the edge of the bone. Below and to the outer side of this sinus, which was discharging yellow-brown pus, was a plaque of purplish skin infiltration. The appearance of this skin plaque, the sinus and the history of the case, led several of the staff independently to a diagnosis of actinomycosis. Accordingly,

Doctor Berg was kind enough to transfer the case to me (service of Doctor Elsberg). No actinomycetes were found in the pus then and none was ever found later, either in the pus or in any tissue removed. It is significant, however, that the patient volunteered and insistently repeated the statement that he felt sure the sinuses had communicatd with the bowel because *on several occasions he had seen "tomato seeds" in the pus.*

August 4, 1922: *Operation* (Brickner). Methylene blue solution was injected into the sinus, which was followed boldly throughout its entire extent by free incision and

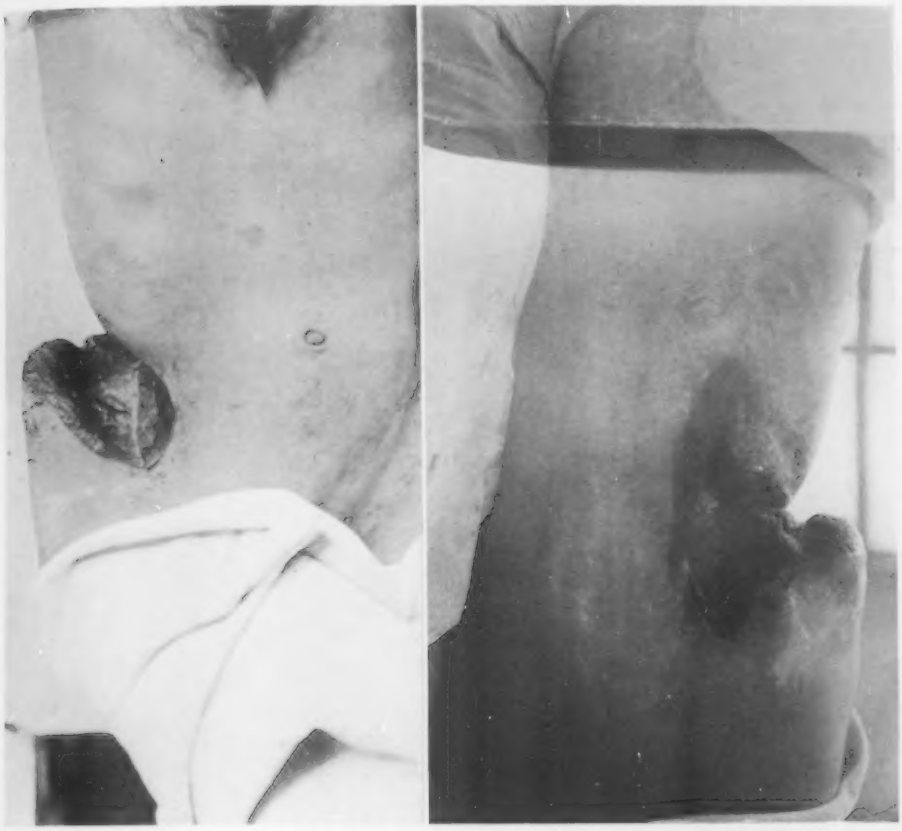

FIG. 6.—Case IV. Everett S. Photograph soon after first operation (August, 1922).

dissection. It was found to pass upward over the edge of the crest of the ilium, which was barely exposed, and forward under the muscles of the back and abdomen where it extended both upward along the spine and downward into the pelvis between the peritoneum and the overlying muscles. Another branch extended downward through the gluteal insertions into the skin swelling above referred to. All of these extensions were laid freely open and excised or curetted out. Within the pelvis the sinus expanded into a large pocket extending midway between the anterior superior spine of the ilium and the symphysis pubis, external to, but in contact with, peritoneum and filled with grumous and jelly-like material. The same material was found in the expansion of the sinus extending upward in the back muscles and along the spine. This tissue, which was removed, was amorphous and no actinomycetes were found in it. The entire wound dividing the back muscles from about the second or third lumbar level, and the abdominal muscles to half-way between anterior iliac spine and symphysis, was left

wide open, causing the extensive mutilating defect shown in Fig. 6. It was treated with simple gauze packings and bland irrigations, for the patient had shown a decided intolerance to iodine, whether used locally or administered internally. In three weeks the wound was scarcely discharging and was covered throughout with healthy granulations. There had meanwhile appeared a contamination with bac. pyocyaneus which yielded less promptly than it usually does to daily liberal dusting of the wound with powdered boric acid. August 25, I sutured the gaping abdominal muscles, which healed by primary

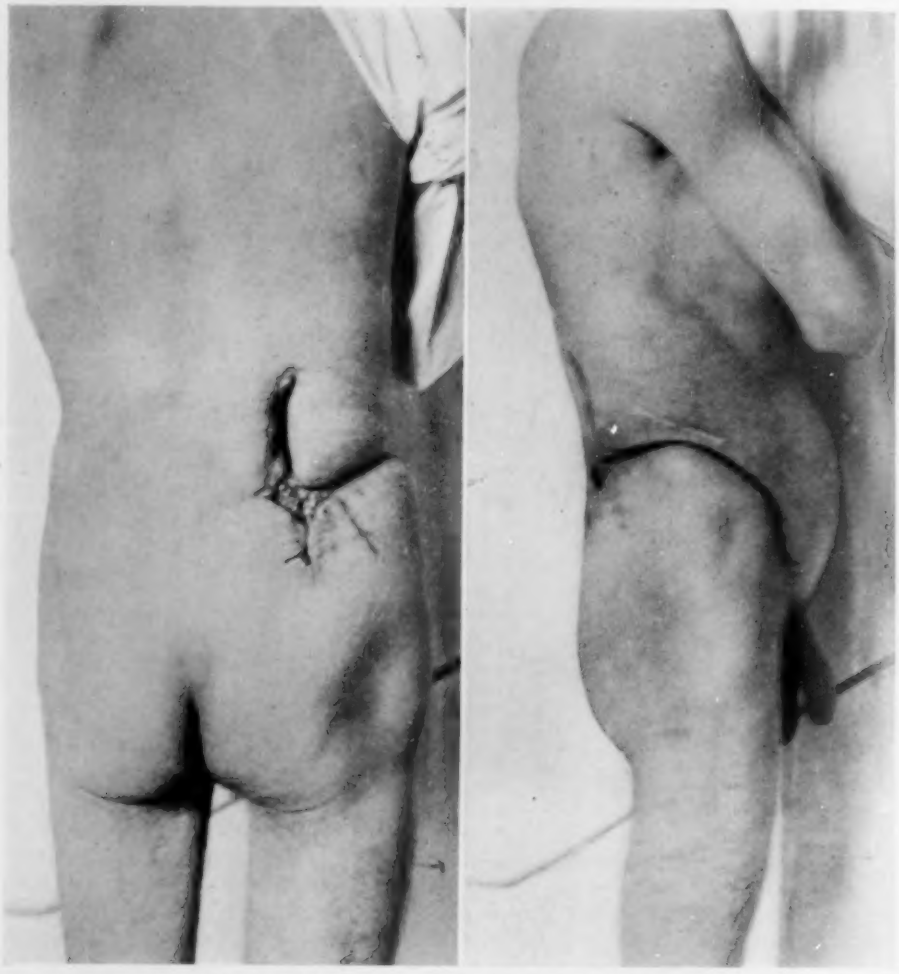

FIG. 7.—Case IV. Everett S. Photograph September, 1922, after secondary suture of abdominal muscles.

union. I thought it wise, however, to leave the upper portion of the wound open (Fig. 7), and I also left a drain extending down into the lower portion. The patient was discharged from the hospital September 30, with the lumbar wound not entirely closed but granulating.

At that site, a little above the crest of the ilium, a sinus, discharging creamy pus, persisted in spite of injections of various antiseptics, including acriflavine. Therefore, on March 26, 1923, I had the patient admitted to my service at the Broad Street Hospital.

March 27, 1923: *Operation* (Brickner). Sinus injected with methylene blue solution.

To dissect it out completely it was found necessary to reopen the wound of the preceding operation by an incision extending upward through the back muscles (but not as far as previously) and downward through the abdominal muscles along the pelvic brim. No abscess or broken-down tissue was found. All colored areas were excised and curetted out, including a few small granulating pockets in the muscles. The peritoneum was opened and a local examination made. There was no evidence of present or past intestinal or omental inflammation. My examination of the ileo-cæcal junction and the caput coli revealed no trace of the appendix, and I concluded, therefore, that it had been the focus of the actinomycosis, which had caused it to slough out completely. Peritoneal incision sutured. Large wound left open and packed with gauze.

The wound scrapings and fragments of sinus tract were carefully examined by the hospital pathologist, Dr. M. J. Fein, who found microscopically "fibrous connective tissue and a great deal of hemorrhage; blood-vessel walls thickened; in one portion are *glands which appear to be Lieberkühn glands;* marked round-cell infiltration; no actinomycetes."

At the first dressing, four days after operation, abundant pyocyaneus contamination was found again. There was no other case of pyocyaneus infection in the hospital or in my practice at the time, and this reappearance of the bacillus in the wound after seven months must be regarded, I am quite sure, as another instance of the longevity of quiescent organisms in the tissues (*vide infra*). Wound treatment by Dakin solution washes and powdered boric acid. Granulations appeared promptly and progressed normally, the large, gaping wound contracting rapidly and with very little suppuration.

April 18 I noticed in the granulations over the peritoneum a very small pouting rosette of what looked like mucous membrane. This rosette appeared to surround a small sinus leading under the peritoneum about 1.5 cm., and not discharging. With a probe passed around this area a column of tissue was dissected up, leading into the abdominal cavity. Within this column a fine probe entered a channel. I concluded that this hollow column was the appendix and would have to be removed to effect a complete wound closure and cure. The manipulation of the tissue was followed by a sharp febrile reaction and considerable suppuration for a few days.

April 26: *Operation* (Brickner). Through a small opening in the peritoneum the column of tissue bearing the rosette of mucosa was dissected up with the finger. It proved to be the appendix, retrocæcal and about 10 cm. long, which, with its mesenterioleum, had been shut off from the general peritoneal cavity. The cæcal end was readily identified and here the appendix was removed by the ligature method. Small gauze drain inserted.

Serial sections of the appendix were examined by Doctor Fein: "No evidence of actinomycosis. All coats thickened, and show round-cell infiltration here and there; proliferation of fibrous connective tissue; lymph follicles obliterated; catarrhal inflammation of the mucous membrane."

This last operation was followed by a severe febrile reaction (104°), much vomiting and considerable suppuration for a few days, and this was succeeded by the appearance of a minute opening in the cæcum at the site of appendix amputation. This fecal fistula closed in ten days, and thereafter wound healing proceeded normally. May 26, the patient left the hospital in excellent condition. Within a short time healing was complete.

In the eighteen months that have since elapsed he has had no indication of any recurrence and he has continued in good health.

Case V.—Mrs. Rebecca M., sixty-five, consulted me August 13, 1921, concerning a painless, indurated, purplish-red swelling, surmounted by a very large pus-bearing bleb, just below the line of the right groin, which had been forming for a few days. The bleb was quite flaccid, but contained so much pus that it was in danger of rupturing at any moment. The indurated swelling was scarcely tender. Temperature 100°. In the

line of the groin itself, was a long, well-healed, incisional scar. Vaginal, rectal, abdominal and urinary examinations negative.

The patient gave me the following meagre history: About twenty years previously she was very ill with what I learned subsequently from her then family physician was thought to be some inflammatory gynæcological condition, and Dr. Joseph Brettauer opened an extraperitoneal abscess in the right groin. It discharged for some time and then healed completely. About six years later she was again operated upon while out West, and she was quite sure that glands in the right groin were removed and pus was evacuated; after draining for a while the wound again entirely healed. About seven years later a swelling in the groin was again drained, again with complete healing; and the patient had been entirely well for another seven years until the above-described swelling appeared three or four days before I saw her. She did not know what the cause of these suppurations in the groin had been and was vague as to the character of the operation performed and even the names of the surgeons.

It seemed to me that the only condition having the appearances then presented that could provide a history of recrudescences over a long period of years was actinomycosis. I evacuated from the vesicle characteristically foul-smelling pus in which I saw no sulphur bodies. I submitted a smear to Dr. Eugene Bernstein, who reported finding actinomycetes and staphylococci. This finding has been corroborated by others who have examined the smear, which shows interlacing mycelia but no clubbed organisms. With the pustule opened, a sinus was found leading upwards in the direction of the iliac glands and then backwards towards the obturator region within the pelvis. Potassium iodide was administered. The mass rapidly subsided and the sinus closed promptly without any further treatment. August 25, healing was complete, and when I last saw her, several months later, the patient had had no recurrence. I advised her to take potassium iodide at intervals as long as she lives.

In Case II the pelvic actinomycosis was probably a late extension downward. In the other four cases the disease appears to have had its origin within the pelvic zone, and to have extended but relatively little beyond it. Indeed, it is one of several interesting features presented by this series that abdominopelvic actinomycosis manifested over periods of, respectively, 3, 11, 4, 2 and 20 years, showed no tendency to invade kidney or liver. In Case II, however, the liver was enlarged for several months. In Wynn's [2] recovered case of "actinomycosis of the lung and liver," with empyema, there was an hepatic enlargement down to the level of the umbilicus, not submitted to operation (*vide infra*).

There have been numerous reports of actinomycosis originating in the appendix or cæcal region, and several of actinomycosis of the female internal genitalia, but there are very few recorded instances of pelvic actinomycosis without demonstrated visceral involvement, comparable to Case I and Case V. Dürring,[3] however, reported the following striking case in a female of thirty-seven:

Mass in right side of pelvis extending into right iliac fossa. Large amount of ichorous pus evacuated below Poupart's ligament. No fever. Urine clear. Incision healed. Four months later stinking abscess evacuated in right lumbar region above iliac crest; finger entered within flare of ilium. A few weeks later pus ruptured into bladder and pelvic mass became smaller. In pus from bladder characteristic granules and ray fungus found for the first time.

Autopsy: Muscles and fasciæ on right side of pelvis infiltrated in a mass, perforated with fistulæ, extending to lower pole of right kidney and to midline of sacrum. Bladder

adherent; small perforation. Periosteum thickened. Pelvic bones and last four vertebræ (and sacrum), especially on right side, showed a remarkable osteoporosis, erosion and multiple pitting as though struck by birdshot. Much of bone translucent, exceedingly light of weight. Also irregular new bone formation. Intestines and genitalia normal. Appendix short and adherent. Sections of intestinal tract, respiratory tract and genitalia negative. No primary focus discovered.

In the fatal cases reported as "pelvic actinomycosis" by Zimmerman [4] and by McMorrow,[5] there was no autopsy.

The generally credited portals by which the actinomycetes enter the body are: the mouth and pharynx; the respiratory tract; the gastro-intestinal tract (including invasion of the mediastinum from the œsophagus); the skin (rarely).

In Case I invasion through the skin cannot be excluded. It is more likely, however, that it took place through the intestinal tract, perhaps the appendix if pointing into the left side of the pelvis, but more probably the sigmoid. Frazer and Berkman[6] report the case of a man, fifty-five, with a mass in the left iliac region which, upon exploration, was declared an inoperable carcinoma; sinuses formed, with purulent discharge containing myriads of sulphur bodies; röntgenograms showed a large filling defect in the sigmoid colon; after one deep X-ray treatment and potassium iodide, gr. 80 t.i.d. at intervals for seven months, the mass "practically disappeared," leaving one small sinus draining occasionally.

In Case II the invasion probably took place into the left side of the abdominal wall from the (adherent) descending colon, and into the right side from the ascending colon or hepatic flexure. In Case III the primary focus was probably the appendix; in Case IV probably the tip of the appendix. One may speculate, however, whether, in Case IV, the bullet passing into the right ilio-lumbar region, followed a month later by a large lumbar abscess and two years thereafter by a persistent diarrhœa, may possibly have carried the organisms in with it or, perhaps, have injured the intestine and thus stirred actinomycetes therein into activity. In Case V, too, the appendix, perhaps extraperitoneal, may have been the focus.

There is good reason to believe that actinomycetes may pass through the gut wall into, or that intestinal actinomycosis may subside while the disease is progressing in, contiguous structures; and that, therefore, intestinal actinomycosis is not the uniformly fatal malady it is generally thought to be. Hüffer [7] says Harbitz and Shiota (reference not given) emphasize that actinomycetes in their passage through the intestinal wall may make such insignificant lesions that the most painstaking examination can hardly demonstrate the site. That an actinomycotic mass may disappear while the infection is spreading is not a rare phenomenon. It is exquisitely illustrated in Case II in which the large mass on the left side of the abdomen, which contained yellow spots, and which was explored but not removed, had completely disappeared when the patient returned to the hospital ten years later. The hepatic enlargement in that case and, especially, in Wynn's case, also suggests

the possibility that actinomycosis of the liver may subside without drainage. Robertson [8] and Caldwell [9] each describe an autopsied case of hepatic actinomycosis in which the source of the infection could not be found. In these two and in similar reported cases, the liver may have been involved by extension from an extinct intestinal focus, or by passage of the organism through the gut wall (as suggested by Robertson) or by its carriage through the portal venous system. Aribaud [10] collected eleven cases in which he believes the organisms entered the liver by the veins.

Concerning actinomycosis arising from the appendix and cæcal region Brockman,[11] and also Warwick,[12] present an interesting explanation. Brockman regards "actinomycosis of the right iliac fossa" as more accurately descriptive than "ileo-cæcal actinomycosis" for, he says, "In cases of infection in this region with *actinomyces bovis*, investigations go to show that the intestine and appendix are themselves free from actual lesions, whilst the muscles and connective tissues of the right iliac fossa are the primary seat of the disease." He asserts that "Cases of infection of the cæcum have been reported, but no recorded case of a similar condition *in the walls* of the appendix can be found [italics mine]. The appendix plays purely a secondary part in the etiology of this disease of the right iliac fossa. It acts as a *locus minoris resistentiæ* through which the organism escapes into the retroperitoneal tissues." Warwick says "It is not often that actinomycosis is suspected at the time of operation for an acute attack of appendicitis. That diagnosis is prompted by the subsequent history. It is quite conceivable that the appendicectomy itself may have been the final cause determining the onset of actinomycosis in a certain number of cases."

Recorded cases of actinomycosis of the female internal genitalia have been collected by Hamm and Keller,[13] Wagner,[14] Robinson,[15] Hüffer.[7] These authors, Schmidt,[16] Frank,[17] and others express the opinion that the involvement is "always" or "almost always" by extension from the intestine. Conceivably it might also occur by extension through the pelvic tissues from the vulva, and in two of the cases collected by Hüffer it was presumed to have developed from the skin. Infection through the vaginal tract is doubted by Wagner, Hüffer and others. The few cases reported as instances of such infection are open to grave doubt (that of Grainger Stewart and Muir,[18] for example, exhibited a sinus leading into the vagina which probably was an extension downward); and the validity of the assumption of this mode of entry in these few cases is disputed by several others. Hüffer and Schmidt admit as the only acceptable instance of actinomycosis invading the uterus through the vagina a case of Giordano (reference not given)—a poultry raiser, accustomed to handle grains, who had a uterine prolapse. Hüffer quotes Tönnies as admitting the possibility that actinomycetes may be introduced, on a foreign body, into the urethra or vagina. But, as Hüffer mentioned, only one case of urethral actinomycosis has been reported—that of Poncet [19] in a male.

Hüffer presumed that four of his collected cases were metastatic through the blood stream, and he refers to the observation of Wunschik [20] (whose dissertation was unavailable to me) that the mycelia were repeatedly found in leucocytes. The term "metastasis" has been too loosely used in connection with this disease. Involvement of the liver and lung in abdominal actinomycosis, of the liver in pulmonary and mediastinal actinomycosis, is almost always by direct extension. Trevithick [21] reports as an instance of possible "metastasis" the following remarkable case:

> Emaciated boy with consolidation and cavity in one lung. Spontaneous recovery after expectoration of very offensive pus containing interlacing streptothrix. One year later large mass developed in pelvis and lower abdomen; abundant yellow bodies and interlacing mycelia in pus from spontaneously discharging abscesses; fecal fistula; spleen enlarged; again spontaneous recovery!

Here the abdomino-pelvic involvement, no doubt intestinal, was probably not by metastasis in the usual meaning of the term, but from swallowing expectorated actinomycetes.

That actinomycosis may occasionally be blood-borne can scarcely be disputed. Reference has been made to presumed transmission to the liver through the portal system. Instances of primary actinomycosis of the kidney cannot be accepted as such if for no other reason than that extension from the colon can not be excluded; in some of these cases, however, there is a strong probability of renal invasion by embolism. Job [22] states that in actinomycosis "thromboses and emboli have been found in the vessels up to the right heart." The nervous system provides less doubtful evidence of blood-stream transmission. Bollinger [23] reports as an instance of primary actinomycosis of the brain the post-mortem finding of an isolated typical actinomycoma in the third ventricle of a woman with bad teeth, presumed to have had a brain tumor. There was found no involvement of the meninges or the cranial bones, and no evidence of actinomycosis, gross or microscopical, in any other tissues of the body. For this to have been a "primary" invasion of the brain, however, one would have to assume, as Bollinger believed, that the organisms entered directly into the blood stream from the mouth. It is at least as likely, as Job also suggests, that such isolated lesions in the nervous centres are metastatic from some extinct focus. Ferré and Fouquet [24] report as probably primary a brain abscess containing streptothrix—ramifying filaments with knoblike terminations. Musser, Pearce and Gwyn [25] report a foul-smelling abscess in the Rolandic area containing masses of streptothrix filaments; autopsy on head only. Almquist's [26] case of cerebro-spinal meningitis with only one colony of streptothrix found in cultures, is doubtful. Howard [27] accepts the above cases, except Almquist's, as instances of primary actinomycosis of the brain, and adds as a fourth case that of an acute abscess of the temporo-sphenoidal lobe (autopsy) containing mycelial organisms, and without evidence of involvement of any of the basilar structures. In addition to these Howard accepts, among thirteen cases of secondary actinomycosis of the nervous system, several (Israel, Naunyn, Eppinger, Sabrazes and Rivière,

Martin, Chiari) as probably metastatic—chiefly from the lung, one (Naunyn) from a heart valve. (Moersch's [28] study of central nervous system actinomycosis developed that the affection is usually of the meningeal type, the invasion taking place by contiguity).

It is probably true, as so often stated, that actinomycetes do not travel through the lymph-vessels—although Aribaud and Israel believe that this is possible and occurs, with blood stream invasion, in the "pyemic" form of the disease. The equally common and emphatic statement that "the lymph glands . . . do not appear to react in any way to the fungus" (Cope [29]), "the lymphatic system is never involved . . . the lymph-nodes are never enlarged" (Hinglais [30]) is not universally true, as shown by Case I, in which there was an indubitable and extensive actinomycotic involvement of the iliac nodes. (In Case V, there may also have been such a gland involvement. Bevan's [31] case of actinomycotic "inguinal bubo" associated with actinomycosis of rectum and both hip-joints, and McKenty's [32] three cases of actinomycosis of the groin which he believed were glandular abscesses, were not clearly described as lymph-node involvements.)

It has also been stated that "the periosteum and bone are very rarely invaded by actinomycosis." [30] Colebrook says it is unusual. Sanford and Magath [33] assert that "actinomyces does not involve bony structures." This is not correct. Neither bone nor, apparently, any other body tissue is immune to invasion by the disease. There was an involvement of the ilium in Case I and Case III. Instances of actinomycosis of jaw, cranial bones, vertebræ, thoracic cage, are not rare. In Dürring's [3] case the invasion of the pelvic bones and lumbar vertebræ was very extensive.

Case V is unique, I believe, in the very long periods of latency. In Trevithick's case there was an interval of a year between the pulmonary and the pelvic involvements. One should be slow to pronounce a healed case "cured."

In the present series, and in other cases of actinomycosis that I have seen, it was observable that pain and tenderness were distinctly less than in ordinary pyogenic processes of the same size and situation.

In Cases I–IV granules were observed at one time or another. In Case V the mycelia were in clusters, but they were not aggregated into granules. Less on this account than because of the behavior of this unique case—latent periods of six and seven years, with four outbreaks circumscribed to the groin and subsiding soon after drainage—we may have been dealing with a type or strain of actinomyces differing from the others. The apparent absence of granules during the period of the last recurrence does not, however, gainsay their presence at an earlier occasion, or in the depth. Moreover, it not infrequently happens that one finds only interlacing mycelia in one lesion and granules (also) in another, as in Trevithick's case. Perhaps, therefore, all five of my cases satisfied the granule requirement of Wright.

I shall not enter at great length into the controversy and confusion concern-

ing the classification and nomenclature of actinomycetaceæ and the mode of their transmission to man and to cattle. Infection of humans from other animals is doubted by New and Figi,[34] among others. Wright's much quoted study [35] led him to reject the teaching of Boeström [36] that the mycelial organisms found on grasses and grains are the specific infectious agent of actinomycosis. Such branching organisms, which are sporulating, grow at room temperature and best aërobically, Wright put in a separate group under the name *nocardia;* and the undoubted cases of infection by them he would call *nocardiosis,* not actinomycosis. The latter name he would restrict to " those inflammatory processes the lesions of which contain the characteristic granules or 'drusen,' " an infection by the *actinomyces bovis* of Bollinger and Harz—a non-sporulating branching microörganism, not found outside animal bodies, grown best anaërobically and not at all at room temperature. Wright thinks that *actinomyces bovis* is probably a normal inhabitant of the buccal cavity and gastro-intestinal tract of man and animals. Lord [37] reports that he found actinomycetes in the carious teeth and tonsillar crypts of individuals who did not have the disease, and that he produced typical lesions by inoculating guinea-pigs. McWilliams [38] reports a case of actinomycosis of the finger following a cut by an adversary's tooth. Warwick [12] reports a case of pulmonary and pleural actinomycosis developing after the inspiration of a carious tooth; and there are many instances of the disease following tooth extractions. Cope [29] notes the intimate relationship between carious teeth and peribuccal actinomycosis, but appears to regard the former as portals of entry rather than as sources of actinomycetes.

The theory of Boeström cannot be easily dismissed. Several after him have also found fragments of grasses and cereals in granule-bearing lesions in man and cattle. Colebrook, whose extensive bacteriological and clinical studies of actinomycosis [39] command attention, and who is wholly in accord with Wright's views, himself reports [40] finding in one of his cases a blade of grass in a granule-bearing abscess. Suggestive, too, are the cases in which the disease has followed penetration of the bucco-pharyngeal mucosa by a straw or beard of grain—although here, as Wright suggests, the foreign body may have merely made a portal of entry. Mattson [41] marshals many arguments in support of Boeström and says that while the organism isolated in man by Wolff and Israel, and more fully described by Wright, is the only one producing actinomycosis, there is much clinical and biological evidence that it has its source outside the body and is capable of a dual existence, first as a saprophyte in old sod soil from which it gains access to grains and grasses through which as a medium or intermediary host it can infect man and lower animals.

Whatever may be the importance, bacteriologically, of distinguishing the mycelial organisms that have been variously and varyingly called actinomyces, discomyces, streptothrix, cladothrix, nocardia, etc., it does not appear that it affords any basis for differentiation, clinically, among cases that we recognize as, and call, " actinomycosis." In his recent study of the distribution of the

disease in this country, Sanford [42] discards the nomenclature and cultural differentiation of Wright, which he had previously adopted and, following the recommendation of the Committee on Nomenclature of the American Society of Bacteriologists, he classes the so-called nocardia and streptothrix as actinomyces, and recognizes as actinomycosis a disease produced by these various strains, whether acid-fast and aërobic or not.

In Case I the granules disappeared from the pus a few weeks after the first operation. In Case II they were found only at long intervals. In Case III they were never seen by us in the pus (where, presumably they had been noted at the Mayo Clinic), but they were found in the mass that I removed at the first operation. In Case IV they were observed several times by the patient but never by us in pus or tissue. In Case V clustered mycelia were found in the pus in the last outbreak, but no granules. It is evident from these and many other recorded cases that the appearance of these "sulphur bodies" is quite vagarious. An actinomycosis may be well advanced and suppurating for many months before a persistent search for the organisms is rewarded; after drainage (and secondary infection) they may disappear from the pus; or the granules may be found only at long intervals, or they may escape continued observation in the pus and yet be found in the tissues. The granule is a diagnostic fetich. Its absence from the pus has often led to failure to recognize the disease during life. Wagner,[14] stressing this, suggests that some cases of presumed adnexal tuberculosis may be actinomycosis; and in the case of Hamm and Keller [13] this error had been made. With or without the presence of granules or of non-granule-forming mycelia, actinomycosis may be—and should be—diagnosed when the history, the behavior and appearance of the lesions (and often the odor of the pus), are characteristic.

Potassium iodide did not exercise any demonstrable benefit in this series of cases, even in those in which it was given in very large (in one case, huge) doses over long periods, as is recommended by Bruce,[43] Mattson, New and Figi, and others. That the circumscribed lesion in Case V subsided promptly, after drainage, while the patient was taking potassium iodide, is not significant, for in the previous outbreaks it subsided after simple drainage. Nor is there any reason to believe that the iodine injections and irrigations employed in this series had any specific influence. In Case I the injection of a 50 per cent. solution of potassium iodide into the persisting sinus was followed by a violent inflammation, gradual subsidence and definitive healing. This phenomenon, however, may be interpreted rather as a chemical tissue reaction than as a specific effect of the drug. And, too, in interpreting the events after the employment of any agency it must not be forgotten that actinomycosis sometimes completely subsides spontaneously. In a severe case reported by Lange [44] complete healing followed the injection of a 4 per cent. solution of zinc nitrate.

In the "wooden tongue" of cattle (as was first shown by Nocard) and in "lumpy jaw," potassium iodide, recommended by Thomassen in 1885, is regarded by ranchers, veterinarians, and our Bureau of Animal Industry [45] as

well-nigh specific, although incision and excision of submaxillary masses are also practiced. In human cervico-facial actinomycosis the drug is often of decided benefit, sometimes curative. I have seen a threatening actinomycosis of the parotid region subside and almost disappear with no other treatment.

On the whole, the effect of potassium iodide is very uncertain. Some cases are reported as taking the drug "pound after pound and month after month" without benefit. On the other hand, Bérard [46] says "Success is fairly constant when K. I. is administered internally, no matter what may be the site of the lesion—excepting the nervous centres—nor what may be the form affected by actinomycosis." From the experimental side Henrici and Reynolds [47] found that potassium iodide had no influence in guinea-pigs inoculated with *actinomyces asteroides*.

Copper sulphate, introduced into the therapy of actinomycosis by Bevan, [48] to be used internally and in 2 per cent. irrigating solution, in addition to potassium iodide and X-rays,[49] was altogether disappointing in the four of my cases in which it was tried. Von Baracz [50] reported the recovery of 30 out of 35 cases after parenchymatous injections of 1 per cent. copper sulphate solution. Nitrate of silver, in 20 per cent. solution, injected into the tissues, also gave good results in the hands of von Baracz [51] who reported the cure of 9 cases (location not stated) without operation.

Neosalvarsan appeared to be of no benefit in the only case of this series in which it was used. Telford [52] reported rapid improvement in one of two cases of parotid actinomycosis after 0.3 neosalvarsan; free drainage and iodine were also employed, however.

In Case III the X-rays and radium had been employed systematically at the Mayo Clinic without benefit. Probably in massive deep lesions radiation is not helpful. In the more superficial lesions of the cervico-facial region it has often given excellent results. Thus, Jüngling [53] cured 11 out of 12 cases, using less than 50 per cent. of an erythema dose; Heyerdahl,[54] using radium, describes 6 cases, of which 5 were cured and 1 improved; Jensen and Schery [55] report cure of a facial case after two X-ray treatments (using also methylene blue locally and internally); Steinke [56] records a facial lesion with discharging sinuses healed after a single X-ray exposure to secure a röntgenogram.

Vaccines have been employed, especially by the British, with what are reported in several instances as excellent results. Colebrook,[40] who records the largest series in humans believes that vaccines facilitate recovery; but he emphasizes the importance of surgical treatment—incision and curettage (and he advises that the curetting be with a gauze swab, not a sharp spoon). His 6 thoracic cases all died; of 6 abdominal cases, 5 died and 1 recovered. One hand and 11 cervico-facial cases all recovered. In 11 cases he used stock and in 14 autogenous vaccines—3-10 million fragments once a week. In a successfully treated actinomycosis of the parotid region Dean [57] employed four injections, each of 25 million organisms, combined with incision and sponge curetting, and iodides. Mansfield [58] reports a desperate case in which incision

was made through brawny tissues of the neck to prevent suffocation; when abscesses formed great improvement took place under K. I. and the process subsided; later two brawny swellings and a fistula disappeared with vaccine treatment.

Whittier [59] mentions a case of actinomycosis at the angle of the ribs, improving under vaccines, 50-100 millions. Collie [60] reports a case of actinomycosis of groin, back of neck, and nipple region, with emaciation and profound illness; groin abscess drained surgically; K. I. ineffectual; immediate improvement when vaccines were used (17 injections, 5-7½ million); health restored; groin healed; two other wounds healing. Malcolm [61] records a mediastinal abscess drained by thoracotomy; 2 years later, a pericardial nodule and sinuses persisted in spite of large doses of K.I.; healed under 50 vaccine injections. Wynn's [2] case of actinomycosis of lungs and pleura, with enlargement of liver, recovered after thoracotomy and vaccine treatment. In interpreting this (and the other cases), however, one may compare Trevithick's [21] case of pulmonary and abdomino-pelvic actinomycosis which recovered spontaneously, and note Bigland and Sergeant's [62] case of pulmonary, pleural and pericardial actinomycosis, also very ill, in which recovery followed surgical drainage of pleural and pericardial sacs, and intensive iodine treatment.

In cattle Scott [63] finds vaccines a valuable therapeutic adjuvant, virulent antigens giving the best results. Concerning the treatment of massive lesions, however, he says that it is unreasonable to expect immune bodies to reach mycelial foci cut off from adjacent healthy tissues. The same comment may be made of drugs internally administered for such lesions.

I recently had on my service at Broad Street Hospital a boy with actinomycosis of cervical vertebræ, neck and back in whom persistent and thorough treatment with autogenous vaccines, X-rays, radium, potassium iodide and copper sulphate yielded no appreciable result. Only incision and curettage of the abscesses, as they appeared, seemed to afford any palliation.

SUMMARY

There is described the surgical treatment, with recovery, of five consecutive cases of pelvic actinomycosis in which the disease lasted 3, 11, 4, 2, and 20 years. In one the pelvic involvement was a late extension. In one there were four outbreaks circumscribed to the groin with latent intervals of 6 to 7 years.

In all these cases the disease probably originated in the intestine. There is good reason to believe that intestinal actinomycosis may subside while the infection is spreading in contiguous structures. Actinomycosis elsewhere may also subside spontaneously. It is suggested that this may happen in the liver. Neither intestinal nor pulmonary actinomycosis is uniformly fatal.

Involvements of the colon, the appendix and the female genital tract are discussed in certain phases.

Actinomycosis usually progresses by direct extension through the tis-

sues; and the term "metastasis" has been too loosely used. Nevertheless there are instances of conveyance through the blood stream. Those reported as primary in the brain, however, were probably metastatic from an extinct focus.

Actinomycosis probably does not travel through the lymph-vessels. The equally general statement that the lymph-nodes are never invaded is, however, not true.

Neither bone nor, probably, any other tissue is immune to actinomycosis.

Pain and tenderness are less than in ordinary pyogenic processes of the same size and situation.

There is much controversy and confusion concerning the classification and nomenclature of the actinomycetaceæ, and their mode of transmission to man and cattle. Bacteriologic distinctions do not seem to afford a basis for clinical differentiation.

The appearance of granules is quite vagarious; they may be seen in the pus only after a long period, or soon disappear therefrom, or be found only at long intervals, or only in the tissues. The granule (sulphur body) is a diagnostic fetich. Even in the absence of organisms the disease should be diagnosed when the history, the behavior and appearance of the lesions (and often the odor of the pus) are characteristic.

Non-operative measures are discussed. In actinomycosis of the skin and of the buccal and cervico-facial regions, potassium iodide, X-rays, radium, vaccines often give satisfactory results. When the disease is elsewhere they are less reliable. Then, however, bold and persistent surgical attack may accomplish much.

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THEORY AND TREATMENT OF SPIRAL FRACTURES

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Exclusive of certain relatively infrequent and often complicated fractures, *e.g.*, gunshot fractures, most fractures of the shafts of the long bones are produced either by bending or by torsion or by a combination of the two sometimes modified in their effects by concomitant but more often sequent longitudinal thrust.

Fractures by torsion—so-called spiral fractures—are far more common than usually stated. Most so-called oblique fractures are really spiral fractures.

Spiral fractures constitute so large a group, and are so uniformly characteristic in form, that they deserve to be studied as a separate class, for by a proper comprehension of the mechanism of their production most of the clinical phenomena of spiral fractures are obviously explained and the basal principles of proper treatment are made equally evident.

Although much has been published on the mechanics of production of spiral fractures, by which alone their characteristic form and consequent clinical phenomena can be explained, our text-books are singularly silent on the subject. I am therefore emboldened, at the risk of some repetition of parts of my article on Spiral Fractures, published in the Annals, October, 1921, to again call attention of American surgeons to the advantages of approaching spiral fractures from the standpoint of mechanics referring the reader to that article for details.* Moreover this gives me opportunity of correcting certain typographical errors and some important errors of transcription in that article.

It is simply a matter of mathematical necessity and quite independent of the material whether wood, iron, steel, rubber, bone or what not, if bending force is applied to a bar or rod that tensile stresses develop on the side of the convexity of the resulting curve and compressive stresses on the side of the concavity. If the bar breaks as a result of bending, it yields to both tensile and compressive stresses in varying proportions, depending on the brittleness or, per contra, the toughness of the material, for brittleness and toughness have a sort of reciprocal relation.

A relatively tough material yields relatively more to the compressive stresses, witness the buckling fractures of the child's radius or humerus, and a relatively brittle material yields more to the tensile stresses as in the transverse fractures of adult bones or of a cast iron beam or, if one considers a material approaching the limit of brittleness, a chalk crayon where the rod yields almost completely to the tensile stresses.

* For a more general discussion of the mechanics of production of fracture, see Journal of American Medical Association, Sept. 20, 1913, pp. 916–920.

The matter is perhaps not quite so simple as stated, for under conditions of bending, in addition to longitudinal tensile and compressive stresses, transverse tensile and compressive stresses develop. It is by yielding to transverse tensile stress that there is produced, under certain conditions, longitudinal fracture by simple bending or rather fracture in the form of a long curve with its concavity directed toward the side of the concavity of the primary bend of the rod. Thus a long loose fragment may be popped out of a bone on that side.

FIG. 1.—Spiral fracture of femur showing spiral form at upper end of longitudinal component.

It is equally a matter of mathematical necessity that when a bar is subjected to torsion, tensile stresses develop in spiral direction and which are a maximum at the periphery b a l a n c e d by compressive stresses in the interior. The tensile forces tend to lengthen the bar and the compressive forces to shorten it, and the length of the bar will change according as it yields to the one or the other, and this depends, of course, on the distribution of the material in the cross-section as well as the relation between its compressibility and extensibility precisely as a bar subjected to bending stress will shorten or lengthen or break transversely by yielding to the tensile or the compressive forces, according to the properties of the material and in a line at right angles to the effective force.

It was shown by Zuppinger that when a bar breaks under torsion it breaks in a spiral of definite pitch, depending on the relative brittleness of the material and that at the limit of brittleness the lines of maximum tensile stress lie continuously at an angle of 45° with the transverse section. One might consider the lines of tensile stress to constitute an infinitude of parallel spirals, one of which being in the weakest place determines the location of the spiral fissure in which the rod breaks. It is not very far fetched to suppose in a long bone two practically equally weak zones, so that parallel spiral fractures are a theoretical possibility. They have been observed, though rarely. Of course the line of fracture is at right angles to the direction of the tensile stress and therefore constitutes a spiral in the opposite sense.

It follows that in a less brittle material the rod undergoes a greater degree of torsion before yielding and in consequence the angle of effective tensile stress is less than 45° with the transverse section and the resulting spiral

fracture, being at right angles to it, will constitute a spiral of greater pitch. Thus it occurs that in the torsion fractures of old people whose bones approach the limit of brittleness, the spiral fracture makes an angle of almost exactly 45° with the transverse section, and in the tougher bones of children the fracture makes a spiral or pitch greater than 45°. Thus we can say when studying, for example, a nearly transverse fracture, that is, where the line of fracture makes an angle substantially less than 45° with the transverse section, it is not a spiral fracture; it is not the result of torsion.

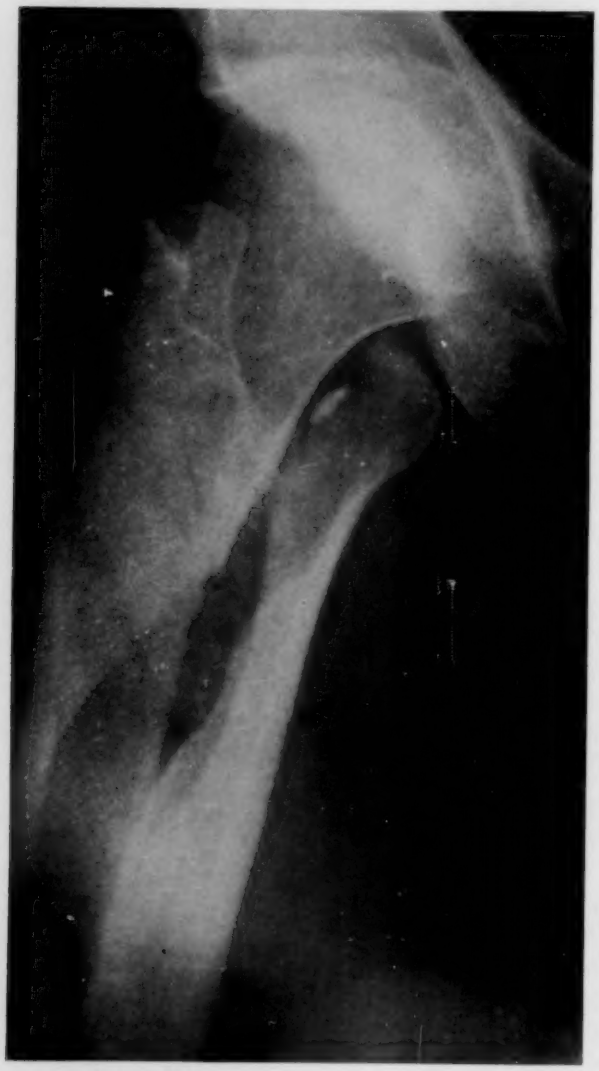

FIG. 2.—Spiral fracture of upper third of femur.

Spiral fractures are therefore invariably the result of torsion, the direction of the spiral being always the same as the direction of the twist, *i.e.*, a right-handed twist invariably produces a right-handed spiral of which an ordinary right-handed screw is a type, and a left-handed twist as invariably produces a left-handed spiral.

Most spiral fractures of the long bones of the right upper and lower extremities are left-handed spirals and of the left upper and lower extremities are right-handed spirals, not because of any spiral grain of the bones, but simply because the extremities are usually broken by external rotation, and this in turn is chiefly the result of the fact that our feet and forearms extend forwards. Internal rotation, though rare, does now and then occur and determines spiral fractures in the opposite directions.

From the foregoing it is evident that axial rotation or torsion produces a spiral fissure in a long bone and this in a bone of just the right degree of

brittleness may be propagated two or even more times around the bone before the fracture is completed by a longitudinal fracture. I have traced the fissure a full double circumference in a young man whose arm was broken in throwing a base-ball.

The instant the bone has yielded in a spiral fissure, there is a sudden change in position of compressive and tensile stresses, the former are developed on the outside of the bone and the latter on the inside in a transverse sense, and since bone ordinarily yields more readily in tensile stress than to compressive, it breaks in a longitudinal fracture which connects two limbs of the spiral completing the fracture of the bone into two fragments. The longitudinal fracture taking place as it does from within outwards, if the torsion continues, the two fragments fold back upon the periosteum as on a hinge. The periosteum is invariably torn on the side of the spiral component of the fracture and not on the side of the longitudinal component.

FIG. 3.—The same case eight weeks after operation.

Because of the pitch of the spiral the longitudinal component of the fracture is not always exactly longitudinal, for in an oblique line directed towards the spiral there is less material to be broken through and commonly the bone yields in such a slightly oblique line, which has given rise to the statement that in spiral fractures the longitudinal component is a reversed spiral, though of very steep pitch.

Bending stress may occur at the moment of fracture, particularly in spiral fractures of the tibia, and would have a tendency not only to determine the fact (Zuppinger) that in the lower third of the tibia the spiral component of the fracture is always in front, but would tend to lessen the pitch of the spiral.

Longitudinal thrust would have the opposite effect of increasing the pitch of the spiral by adding a longitudinal shearing stress, but thrust occurring as

it more noticeably does, after the fragments have disengaged, produces important secondary displacements, causing the sharp ends of the fragments to move about somewhat like blades of shears which sometimes lacerate muscles, wound blood-vessels, or nerves, or penetrate intermuscular septa, tough fibrous tissues, parts of which in consequence get between the fragments and make reduction of the fracture impossible except by open operation.

Objections to the treatment of spiral fractures by traction and other non-operative methods are first, because these fractures cannot be accurately reduced and a little displacement, especially in a rotary sense, leads to a considerable deformity in a clinical sense, and that when so treated they commonly result in noticeable external rotatory deformity leading to fallen arches, in imperfect and often delayed union, because of the entrance of fibrous bands between the fragments, shreds of periosteum overlapping the edges of the spiral component of the fracture comparable to the overlapping of aponeurotic structures over the edges of the fragments of the fractured patella and similarly interfering with union on this side of the fracture.

In a considerable experience I have had much satisfaction in the technic suggested in my article above cited and have had no reason to modify it nor to change the conclusion there put forth that all spiral fractures, except those in children, the very oblique fractures, with very steep spirals, and those which are incomplete and therefore are without displacement, should be treated by open operation unless, of course, they present conditions which contra-indicate operation at all. I except the spiral fractures in young children because their spirals are often so steep that the fractures are practically simple oblique fractures, in which by traction may be secured sufficient correction of displacement to give satisfactory results. But even in the child the advantages of ambulatory possibilities over prolonged confinement with weight and pulley may make operation not only proper but preferable.

The one great argument against operative treatment of fractures is the danger of infection and another the undisputed fact that union in general is slower in fractures subjected to operation and non-union is more frequent. It goes without saying that one should not undertake the open operation treatment of fractures at all unless he and his operating staff have proved that their asepsis is reliable. However, by the technic suggested, the risk of infection is minimized and the probabilities of non-union from other causes as well as from infection are made very small by reason of the fact that the technic is so simple that it entails a minimum of traumatism of the tissues, avoids stripping up of the periosteum and implants a minimum of foreign material, provided of course that the operation is done as a primary procedure.

The blebs and blisters so commonly present in fractures of the tibia offer no contra-indication if the blisters be opened and their floor thoroughly tanned with picric acid. If the bacteria, which are commonly present in such blisters, staphylococcus albus and bacillus pyocyaneus, are not killed, they are effectively enclosed in coagulum.

Briefly the technic recommended is as follows:

Ordinary washing and shaving of the limb to be operated upon are done in the ward. In the operating room the limb is thoroughly washed with ether, rubbing well with gauze pad and using enough ether, then with alcohol 70 per cent., then painting with picric acid 5 per cent. in 70 per cent. alcohol. If grain alcohol is used in making the picric acid solution dermatitis is practically avoided. Formaline alcohol should not be used for that will blister. I have seen but one case in more than a thousand where the use of picric acid in grain alcohol has been followed by a popular dermatitis.

A longitudinal incision is made over the spiral portion of the fracture which may readily be determined by the X-ray, but on the tibia, as said above, the spiral portion is always in front, which is fortunate, for the incision can be made over the flat antero-median surface of the bone.

The bone is exposed, but care is taken not to strip up the periosteum, and blood clots, which cover the medulla and the edges of the bone, are carefully preserved *in situ*. Loose chips of bone which lie between the fragments are removed. The fragments are drilled at points which will be opposite each other when the fracture shall have been reduced. A stout wire of annealed silver is threaded through the drill holes, the fracture reduced by traction and prying and pulling with hooks, care being taken not to break off the long tips of the fragments lifting out shreds of periosteum which may lie over the edges of the bone; the wire is drawn taut and twisted and the twisted ends hammered down against the bone out of the way. The wound is closed and the limb put up in some external retentive appliance, a suspension apparatus, Thomas splint or plaster-of-Paris cast. If plaster-of-Paris is used, complete fixation of joints above and below should be secured in order to prevent rotatory deformity. The plaster case should be removed in ten or twelve days, the stitches removed, the limb massaged, and the joints moved. One advantage of the use of suspension apparatus over that of plaster is that it permits massage and electrical stimulation of the muscles as with a weak Faradic current by which muscle tone is maintained and a greater derivation of blood to the limb is brought about, thereby favoring callus formation and rapid union.

THE ABDUCTION TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR[1]

AN ACCOUNT OF THE EVOLUTION OF A METHOD ADEQUATE TO APPLY SURGICAL PRINCIPLES AND THEREFORE THE EXPONENT OF RADICAL REFORM OF CONVENTIONAL TEACHING AND PRACTICE

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Although it may be assumed that the abduction treatment is familiar by name at least, to the profession, its practical significance is not yet generally, or at least officially, recognized; for it is usually described in the text-books as if the choice between it and other methods were a question of adaptability in the attainment of a common object. The abduction treatment is in no sense such an alternative. On the contrary, it is applied in complete disregard of the precepts of established practice, simply because natural mechanics are utilized to correct deformity and to fix displaced fragments in apposition, to assure, in other words, the primary essentials of functional repair.

Other methods, dependent upon external appliances, are inadequate for this purpose because the neck of the femur projects laterally from the shaft, consequently, splinting and traction can at best appose the fragments only in a lateral and therefore insecure relation. This inadequacy was clearly recognized by Sir Astley Cooper,[2] who classed typical fracture of the neck of the femur with that of the olecranon and the patella, as instances in which non-union was inevitable because it was impossible to control the fragments.

For this reason the protection of incomplete fractures and so-called impactions became a rule of practice, regardless of the effect of deformity on function.

Finally, since the majority of the patients were of advanced age, it was manifestly unwise to subject them to the danger of prolonged treatment which offered so slight a prospect of success.

[1] The elaboration of remarks made on presentation of patients illustrating perfect functional repair at the meeting of the New York Surgical Society of January 23, 1924.

[2] Cooper, Astley: Dislocations and Fractures, Ed. 1, London, John Churchill, 1822. "The neck of the thigh bone, when broken, is placed under similar circumstances (to the fractured patella) for, by contraction of the muscles it is no longer in apposition with the head of the bone and is therefore prevented from uniting; if this, however, were the only obstacle, it might be argued that the retraction of the thigh bone could be prevented by bandaging and extension, the truth of which cannot be denied; but it is scarcely possible, even for a few hours, to preserve the limb in exact apposition, as the patient, on the slightest change of posture produces instant retraction by bringing into action those powerful muscles which pass from the pelvis to the thigh bone."

These conclusions are summarized in the following quotation from a modern treatise on fractures:

"The ideal object of treatment, restoration of form and function, is rarely to be attempted or even sought."

"The first indication is to save life, the second to get union, the third to correct or diminish displacements." (Stimson, *Fractures and Dislocations.* 6th Edition.)

Theoretically, treatment in accord with these indications should be symptomatic or protective, or corrective, in adaptation to the physical condition of the patient, and to the character of the injury, whether intra- or extracapsular, complete or incomplete; practically its quality has been alike for all, a perfunctory routine.

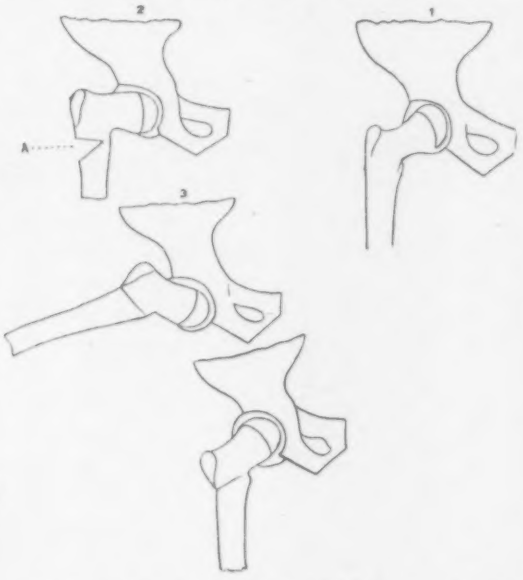


FIG. 1.—The evolution of the abduction treatment. Original diagrams, illustrating the mechanism of the operative correction of fixed deformity of the neck (traumatic coxa vara), 1897.

Bissell (*Phila. Med. Journal,* May 30, 1903) from an investigation at three of the leading hospitals of New York, concluded that as a treatment of fracture, it was absolutely futile, and in a recent paper it is stated, that of 120 consecutive cases of ununited fracture at the hip observed at the Mayo Clinic, not one had received efficient treatment at the time of the injury. (Henderson, *Surg., Gyn. and Obst.,* Feb., 1920.)

The results, even in the cases treated for fracture, as distinct from those in which the saving of life has been the first consideration, have always been extraordinarily bad. The British Committee reported them as satisfactory in but 23 per cent. of the cases examined, a good result implying simply bony union and the capacity for weight bearing. For, according to a British authority, "In all cases function is forever impaired, no matter whether the fracture has taken place within or external to the capsule, whether it has united by ligament or bone, shortening of the limb and lameness are the inevitable results." (R. W. Smith, *A Treatise on Fractures in the Vicinity of Joints,* Dublin, 1847, quoted by Hamilton. Eighth Edition, 1891.)

From this sketch of actual conditions at the introduction of the abduction treatment it will appear, that there had been no essential change from the conclusions formulated by Sir Astley Cooper early in the last century. The

impracticability of adequate treatment had been accepted as a finality. Neglect of the fracture passed as consideration for the patient, functional disability as an inevitable consequence of the injury and non-union as evidence of incapacity for repair. Thus, the dissertations in the text-books, standardized by persistent repetition, have been chiefly concerned with the patient rather than with the fracture and with explanations of failure on other grounds than the obvious lack of opportunity for repair.

The inception of a radical reform dates from 1890, when I identified a fracture of the neck of the femur in a young child and reported it as a surgical curiosity. For at that time the only form of fracture at the hip in early life recognized in the text-books was epiphyseal disjunction, of which a few cases of doubtful authenticity were recorded.

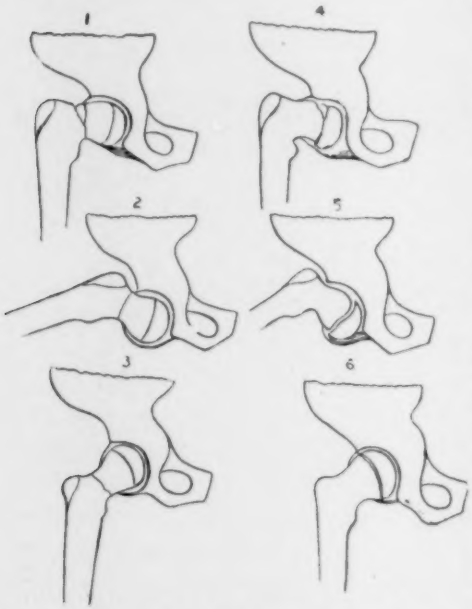


FIG. 2.—The evolution of the abduction treatment. Original diagrams illustrating the mechanism of the abduction method in correcting recent deformity of fracture of the neck and epiphyseal fracture, 1902.

In succeeding years other cases of the fracture in childhood, mistaken for hip disease, came under observation. As the patients were not seen until long after the injury, when repair was well advanced, it was assumed that the condition corresponded to impaction and that the results, according to the accepted standard, might be classed as satisfactory since bony union was assured.

On reëxamination of the patients, however, at later periods it was noted that the disability recorded at the first examination had become more marked, indicating an increase of the primary deformity and of the accommodative muscular contractions characteristic of what is now known as coxa vara. Meanwhile several cases of ununited fracture at the hip in early life came under observation, in all of which the patients had received hospital care.

Fracture of the neck of the femur was thus presented from a new standpoint. It occurred in childhood under the same conditions as in adult life, and entailed the same consequences. The incomplete or impacted fracture caused disability not because of direct shortening, but because the deformity checked the range of abduction and induced an accommodative distortion of the limb. Non-union in childhood could not be explained by insufficient nutrition, but was evidently the result of separation of the fragments. It was equally evident that conventional methods were inadequate either to correct

the resistant deformity of the incomplete fracture, or to appose displaced fragments securely.

Thus, for the first time the problem of efficient treatment of the fracture as a fracture was clearly presented, since in these cases there could be no question either of danger to the patient, nor of the capacity of the tissues for repair. The immediate indication in the group of cases then under consideration, of what has since been termed traumatic coxa vara, was the correction of the deformity. For this purpose, the removal of a wedge of bone at the base of the trochanter, in order to restore the normal angle of the neck suggested itself.

At the first operation it was noted, that contact of the depressed neck

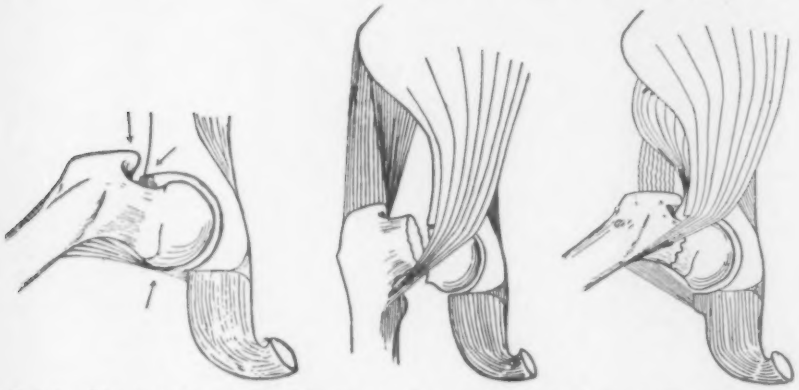


FIG. 3.—The evolution of the abduction treatment. Original diagrams illustrating the mechanism of the method applied for complete fracture, 1904.

with the upper border of the acetabulum provided a point of resistance, that enabled one to close the wedge-shaped opening by simply abducting the shaft. The limb was then fixed in a plaster spica in the abducted attitude until consolidation was complete, and when brought to the middle line the neck was correspondingly elevated, thus relieving the strain which had induced the progression of the deformity and restoring an approximately normal function. (Fig. 1.)

This demonstration was the first step toward establishment of an efficient mechanical treatment for every form of fracture of the neck of the femur. For, if one could correct fixed deformity of the neck indirectly, by abducting the limb after an osteotomy at the base of the trochanter, it was evident that the deformity of a recent incomplete fracture of the neck might be even more perfectly corrected by the same natural leverage. In other words, by abducting the limb to the normal limit and rotating it inward to the required degree. (Fig. 2.)

It was further evident that a method that enabled one to correct the somewhat resistant deformity of an incomplete fracture should be equally effective in the restoring of the normal relations of a complete and displaced

fracture. For, if under anæsthesia the upward displacement of the shaft were reduced by direct manual traction on the limb, slight inward rotation, and abduction to the normal limit would place both fragments in the same plane, while the tension on the capsule incidental to abduction would appose and force them into a direct and resistant contact, which in fractures of the intracapsular type must be essential to repair. The security assured by bony contact and

FIG. 4.—The evolution of the abduction treatment. An X-ray picture of traumatic coxa vara, showing limitation of abduction by the deformity on the left side, and the normal limitation of abduction by bony contact on the right side, the basis of the abduction method.

capsular tension would be further supplemented by the contact of the trochanter with the side of the pelvis; in subcapital fractures by the inclusion of the fracture line within the acetabulum, and finally by the complete relaxation of the muscles, the deforming influence of which according to Sir Astley Cooper, it was impossible to control by any form of external appliance. (Fig. 3.)

Thus, it will appear that the abduction method differs from all other methods in that it utilizes the natural mechanics of the joint both to correct deformity and to fix the fragments, the external support serving only a subsidiary purpose in holding the limb in the attitude that makes the internal splinting effective. (Figs. 4 and 5.)

The comprehensive mechanical efficiency of the abduction method, so-called from its most salient feature, having been demonstrated by its immediate effects, and by the results attained in childhood, it was then applied to cases of the ordinary adult type, since it was evident that there could be no therapeutic distinction between youth and age, or between the intra- and

extracapsular fracture, except, indeed, that in proportion to diminished vitality the more essential to union must be favorable opportunity.

The question at issue was of practicability. Whether efficient treatment of the fracture were more dangerous than "life-saving" neglect. Whether immediate reduction of deformity endangered repair by "breaking up an impaction" or favored it by actually apposing the fractured surfaces. Finally, whether the primary cause of non-union was lack of nutrition or lack of opportunity for repair.

This investigation continued throughout the past twenty years has led to the following conclusions:

Fracture of the neck of the femur is not, as has always been taught, an exception to all other fractures, in the sense that surgical intervention is of little avail. On the contrary, it is the fracture above all others in which the result is most directly determined by the quality of the treatment.

The mechanical obstacles to the strict application of surgical principles are not, as has been taught, insuperable. On the contrary, this is the fracture above all others involving joints, in which the primary essentials of functional repair may be most certainly assured; for resistant deformity may be corrected by natural leverage without violence, separated fragments securely apposed by natural splinting, and the attainment and maintenance of these primary essentials of functional repair may be demonstrated in each case by X-ray examination at the time of operation and at intervals thereafter.

FIG. 5.—The evolution of the abduction treatment. Illustrating fixation of the limb in abduction and inward rotation by the plaster spica, 1904.

The fracture is not, as has been taught, an almost exclusive attribute of old age. It is relatively frequent at this period because the neck of the femur, always a vulnerable part of the skeleton, weakened by general atrophy, is more exposed to injury because of the lessened muscular protection in locomotion, but it is not uncommon in childhood, in adolescence and in vigorous adult life. In fact, in the great majority of cases, it may be treated on surgical principles with perfect safety. Even in aged subjects it has been demonstrated that efficient treatment of the fracture by the abduction method is actually more conservative than life-saving neglect, since it relieves pain, and permitting elevation of the head of the bed and frequent changes of posture prevents hypostatic congestion and bed sores.

Furthermore, it has long since been proved that neither advanced age nor the situation of the fracture precludes repair if the opportunity is assured.

Finally, "shortening of the limb and lameness" are not inevitable. On the contrary, the functional results compare favorable with those of any other fracture of the lower extremity in patients of a corresponding type.

In support of this statement one may contrast the results tabulated by the British Committee with those of an approximately equal number of patients treated by the abduction method reported by Campbell (ANNALS OF SURGERY, Nov., 1919[3]). The majority of these patients were over sixty years of age. There were five deaths (7 per cent. of the number). Twenty-eight of the fractures were intracapsular, and of these twenty-four recovered with bony union and good function (89.2 per cent.). Similar results were obtained in all the fractures of the extracapsular type. Thus, satisfactory results were attained in 94 per cent. of the patients treated as contrasted with 23 per cent., a balance of 70 per cent. in favor of efficiency.

FIG. 6.—The attitude typical of complete fracture of the neck of the femur. The patient is a woman, eighty-five years of age. See Figs. 7, 8 and 9.

Since the report of the British Committee is concerned only with functional results, it may be of interest to supplement it in order to compare the mortality of positive and negative treatment.

R. W. Smith, the author already quoted, analyzed sixty cases of fracture of the neck of the femur under his observation. In 38 cases the fracture was intracapsular with 12 deaths; in 15 cases the fracture was extracapsular with 14 deaths; in 13 cases the fracture was extracapsular and impacted with 9 deaths; in 4 cases the fracture was intracapsular and impacted with 3 deaths. Thirty-eight deaths in 60 cases, a mortality of 63 per cent. In the majority of cases the patients died within two or three weeks from bronchitis, or exhaustion, preceded by fever and delirium, and often accompanied by great pain in the injured limb.

One would hardly be justified in quoting an early Victorian authority

[3] In a more recent paper (Journal Am. Med. Assn., Oct. 20, 1923), Campbell states that he has treated 205 elderly patients with but 10 deaths. Dr. A. R. Shands, who has had a very large experience, in a private communication, states that he has never known of a death that might be attributed to the treatment, although it has been applied to 50 patients over eighty years of age. Waldenström (Journal de Chir., Aug., 1924) reports on 103 cases (1914–1923). Fifty of the patients were seventy or over, and in 59 the fracture was transcervical, yet the death rate was but 10 per cent. and but 5 per cent. of those actually treated for the fracture. There were no deaths in patients under seventy.

were it not that conventional practice has not materially changed in the interval, and because it is still generally assumed that efficient treatment of the fracture is more dangerous than life-saving neglect.[4]

The abduction treatment is rarely described in practical detail in the text-books, and either by inadvertance or intention, various modifications have been introduced, none of which appears to offer any advantage over the original, but quite the contrary. Its application in the ordinary type of complete fracture is conducted as follows:

FIG. 7.—Illustrates the second stage of the abduction treatment, the fragments having been apposed by direct manual traction and inward rotation, the limb is abducted to the normal limit.

Anæsthesia, if not absolutely essential, is of great advantage because complete muscular relaxation is a requisite of complete anatomical abduction, and if properly administered during the short period required for the application of the spica by trained assistants, it is free from danger. The patient having been anæsthetized, is placed on a pelvic support with a perineal bar, the shoulders resting on a box of equal height. Two assistants make manual traction on the extended limbs, drawing the perineum firmly against the bar and completely reducing the shortening on the injured side; the surgeon meanwhile lifting the thigh upward, if it is below the plane of its fellow. Both limbs, extended and under manual traction, that on the injured side being slightly rotated inward, are then abducted to the full limit, on the sound side first, to demonstrate the normal range and to balance the pelvis. (Fig. 7.) When this limit is approached on the injured side, tension on the capsule which surrounds each fragment assures the alignment of the fragments, and

[4] "Only by varied iteration can alien conceptions be forced upon reluctant minds."

by fixing the limb in complete abduction, full extension, and slight inward rotation, the security of the internal splinting is assured.[5]

This description with only minor variations applies to the great majority of cases regardless of the ancient surgical bugbear of impaction, which is in most instances merely a fanciful interpretation of the physical signs that assures neither immediate fixation nor eventual union. The fragments are not usually embedded in one another, but are overlapped, or interlocked, the fractured surfaces being actually separated. This is indicated by a study of

FIG. 8.—Illustrates the thick covering of sheet wadding and bandage to protect the skin from pressure.

the X-ray pictures, and is confirmed by treatment, the deformity being as easily reduced as if the fracture were manifestly complete, the apparently shortened neck presenting after correction a normal outline. One does not in the majority of cases of this type "break up an impaction" because no impaction exists, but in correcting deformity, and thus apposing the fractured surfaces one provides the opportunity of functional repair, as in an incomplete subcapital fracture in which the head is displaced backward on the neck. There is, however, a form of true impaction corresponding to the popular conception, in which the neck is embedded in the shaft, or forced into the head, as is usually clearly shown in the X-ray picture. In such cases one simply abducts the limb and rotates it inward sufficiently to restore fairly normal relations.

[5] It has been suggested that in full abduction there is danger of separating the fragments by opening a gap on the under surface. This can occur only when the neck has been shortened as in cases of non-union. Under normal conditions if the fractured surfaces have been apposed by manual traction and inward rotation, abduction forces the head down to the lower part of the articulation so that the line of fracture of the intracapsular type lies beneath the acetabular roof. The actual cause of failure to appose the fragments is not too great, but too little abduction.

The spica is then applied and the further treatment is conducted as usual. The only forms of resistant deformity that one is likely to encounter, aside from fractures in which treatment has been delayed for several weeks, are the incomplete fractures of childhood and the partial epiphyseal displacements of adolescents, injuries as yet practically unrecognized in the text-books. In such cases one must employ what has been called natural leverage to reduce the deformity. Thus, while in the treatment of the complete fracture the fragments having been apposed by manual traction and rotation, the limb

FIG. 9.—Application of the plaster spica completed.

may be abducted without resistance until the normal anatomic limit has been reached; in these other cases abduction is checked by contact of the outer border of the neck with the upper border of the acetabulum. This acetabular rim furnishes a fulcrum on which, by means of the leverage of the extended limb, one may by forced abduction restore the normal relations of the neck and head. (Fig. 2.)

There are two essential requirements for the proper application of the abduction treatment. The first is sufficient familiarity with anatomical landmarks to verify the apposition of the fragments by manual traction and inward rotation and to assure stability by the complete abduction of the limb to the normal limit upon a level pelvis, this limit being indicated by the range on the uninjured side. One often observes in the practice of others that the abduction is not sufficient to assure anatomical fixation because it is apparent rather than real, the pelvis being tilted upward on the injured side in the place of actual abduction at the hip-joint.

The second essential is the ability to apply a secure and comfortable plaster support to hold the limb in the attitude which makes the internal splinting

effective—namely: full extension, full abduction and slight inward rotation, the knee being somewhat flexed to relieve the strain, the foot at a right angle with the leg and slightly adducted. The plaster spica is called essential, for although other means may be employed to hold limb in proper position, these are so rarely at command that they may be disregarded in a description of a practicable routine.

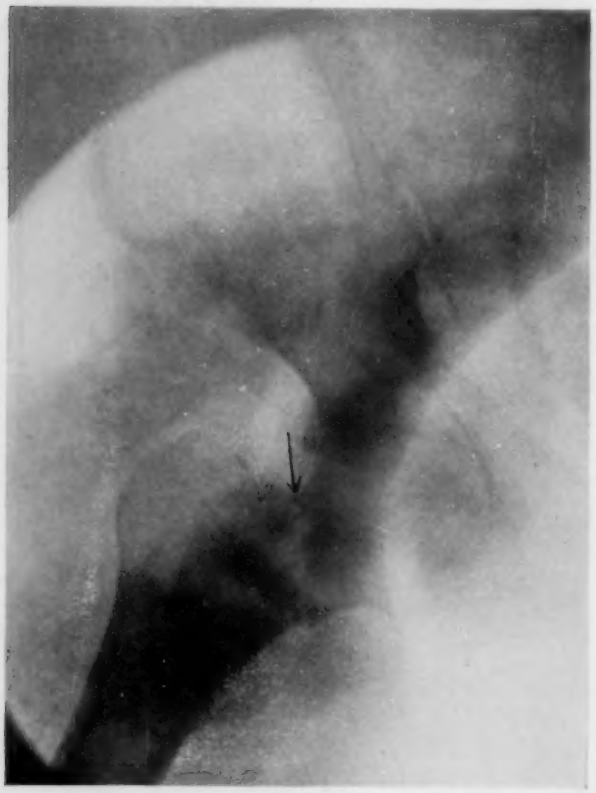


FIG. 10.—After the application of the spica, showing adjustment and fixation of the fragments.

What is called the long spica extending from the axillary line to the toes is the most effective form, the long body portion more nearly equalizing the leverage of the abducted limb. Full extension of the thigh tilts the pelvis slightly forward and thus assures the normal lumbar lordosis. It lessens the pressure on the sacral region and, what is of great importance, makes the ventral attitude as comfortable as the dorsal. Freedom of the other extremity is of advantage because the patient may aid himself somewhat in changing his position. These points are emphasized because, as has been stated, various modifications of the method have been introduced. For example, the spica is applied with the thigh flexed to a greater or less degree, or both limbs are included in the support. The most obvious disadvantage of both methods being the difficulty of turning the patient for ventral recumbency, which in the treatment of the aged is considered of the first importance.[6]

The plaster spica if properly applied assures a general, comfortable and secure support free from pressure or constriction. A close fitting shirting or a "union suit" (Fig. 7) of underclothing is drawn on and covered by a uniform layer of sheet wadding, bound (Fig. 8) securely by Canton flannel

[6] The most practicable modification is that of Shands, of Washington, who, having reinforced the spica laterally and about the pelvis, cuts out the front, leaving only a width of six inches about the pubic region. This permits the patient's trunk to be raised 45° without disturbing the fracture. Doctor Shands, whose experience comprises more than 300 cases, states that he has had no deaths attributable to the treatment, nor non-union in any case in which it had been efficiently applied.

bandages, the padding being made very thick about the upper part of the chest and the sacral region. The spica is usually strengthened at the hip by the insertion of one or more thin steel bars. It is then carefully cut out at the pelvis to permit flexion of the sound thigh and later an outer covering of shirting is drawn over it and sewed to that next the skin, so that all the margins of the plaster are covered by a thick, soft, binding. (Fig. 11.) When the spica has become firm the patient is placed in bed, the head of which has been raised one or two feet, a board having been placed beneath the mattress to prevent sagging. As soon as practicable the patient is turned completely over to the ventral attitude and thereafter at such intervals as may seem indicated. This removes pressure from the sacral region, and is an absolute preventive of both bed sores and "hypostatic" pneumonia. The attitude is so comfortable that in many instances the patients pass as much time in one posture as in the other. At the first turning, one should insert the hand between the sacrum and the plaster splint to assure freedom from direct pressure. It may be noted as one of the great

FIG. 11.—The ventral attitude and elevation of the head of the bed that prevent the usual complications of the persistent dorsal recumbency required in conventional treatment. An outer covering of shirting has been drawn over the spica and sewn to the inner (Fig. 7), thus providing a soft binding for margins of the plaster splint.

FIG. 12.—Turning the patient. At first several assistants may be required to turn the patient easily or as it were "in one piece."

advantages of the abduction treatment that it is under single control in the sense that the maintenance of what has been termed the opportunity for repair is not dependent upon the coöperation of the nursing staff, which under other conditions is essential, in order to make even a semblance of efficiency tolerable to the patient. This point may be emphasized by quoting from a paper entitled "The Science and the Art of Surgery as Applied to Fracture of the Neck of the Femur." [7]

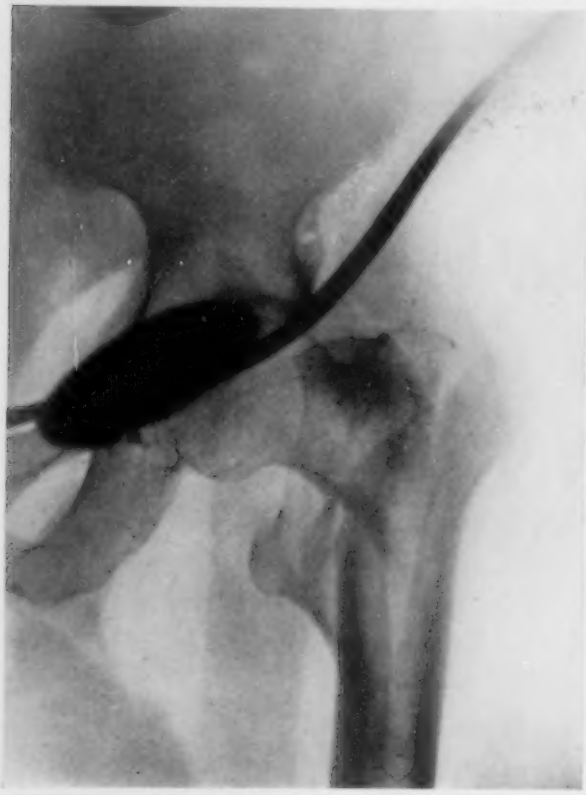


FIG. 13.—A shattering fracture at the base, in a man sixty-seven years of age. See Figs. 14 and 15.

The author states that a proper bed is the first essential, since "the ordinary mattress soon becomes foul and mouldy from perspiration."

Sufficient traction is applied to overcome the shortening in two or three days, yet not sufficient to disturb a possible impaction.

"The surgeon must visit the patient twice daily for two weeks, and once a day thereafter 'because the nurse can not be trusted to carry out the essential details,' one of which is to bathe the back and buttocks twice daily with alcohol.

"It is exceedingly common for patients to become delirious at the end of the first week."

For self-protection the surgeon should always inform the patient of the probable result of the injury. He, therefore, reads to him the statement of Sir Astley Cooper to the effect that in the great majority of cases permanent lameness will follow, and that in many instances the support of a crutch or case will be required for locomotion.

It may be noted of these cases treated by traction, as of those reported by Smith, in which treatment was apparently essentially symptomatic, that delirium was "exceedingly common," and since it is exceedingly uncommon in patients treated by the abduction method, it may be inferred that persistent dorsal recumbency, whether enforced by apparatus or by the pain of an unsupported fracture, is an important predisposing cause. This writer's acceptance of Sir Astley Cooper as a final authority supports the statement that there has been, at least until very recent years, no material change in the teaching which he formulated early in the last century.

[7] New York State Medical Journal, Dec., 1911.

Personally, it has never seemed necessary to impress upon patients the danger of the injury or its disabling consequences because on this subject they are usually well informed. On the contrary, the favorable prognosis both as to life and function now warranted by the results of efficient treatment is of the greatest value as an immediate mental and physical tonic which reconciles the patient to the prospect of the prolonged restraint required to justify it.

Since the treatment of the fracture as such, is under the control of the surgeon, the nurse, relieved from this responsibility, and from the care of bed sores and other complications of enforced dorsal recumbency may devote her entire attention to the care of the patient. It must be especially impressed upon her that the abducted limb must be permitted to project from the bed regardless of nursing æsthetics, for if this long arm of the lever is pushed inward, the opposite margin of the thoracic portion will be thrust against the chest. Also that in lifting or turning the patient the proper relation of the support to the body must be preserved.

FIG. 14.—Taken through the spica.

Since the spica is an independent splint, and since movement causes no discomfort, patients may be transported daily to the open air, and fixation in the abducted attitude even permits locomotion without injury as has often been demonstrated by young and unruly subjects. The spica is retained from eight to twelve weeks, or until it may be assumed, or demonstrated by Röntgen-ray examination, that union is sufficiently firm to permit movements of the limb. On its removal the patient should remain in bed devoting, if possible, several weeks to muscular reëducation and to the restoration of motion in the disused joints, the limb being drawn out to the limit of abduction at regular intervals by the attendant.

Full weight bearing is not permitted until free and painless movement and Röntgen-ray examination indicate stability of repair. Thus, what may be

termed physiologic treatment of fracture of the neck of the femur is rarely completed in less than six months and in those of the central type it may require a much longer time. If, therefore, early locomotion is desired a protective hip brace should be provided.

It may be noted in this connection, that while in the treatment of fractures involving other joints early movement may be of advantage in stimulating repair and conserving the muscular tone, in fractures of the small part of the neck prolonged fixation is as essential to interstitial repair, as it is for bone grafting,[8] while in those at the base complete rest should lessen the tendency to the irrregular callus formation so often seen in museum specimens. In some instances the support may be removed below the knee at the end of four weeks to permit movement, but this is of doubtful advantage since the leg often swells and the pressure of the lower border about the knee may cause discomfort when the patient is moved. In my own experience motion in the disused joints may be restored by massage and exercise long before the injured part is capable of weight bearing.

FIG. 15.—The final result, the important point being the restoration of the angle of the neck. This patient was presented before the Surgical Society eight months later to illustrate a perfect functional recovery.

From the conventional standpoint the fracture as such has always been a minor consideration and even in cases in which treatment has been applied with the aim of promoting repair, functional use to the point of tolerance is usually encouraged long before consolidation can have been completed. Premature weight bearing will prevent union in central fractures and in those at the base it may increase the already existing deformity or stimulate excessive callus formation incidental to it, thus directly limiting the range of motion. Of

[8] Waldenström contrasts two groups of cases, in one of which he attempted to apply the principles of the abduction treatment by multiple traction. In this group bony union was attained in but 13 per cent. as contrasted with 55 per cent. of those treated by the plaster spica. The larger proportion of these patients were over seventy years of age and in several instances the treatment was ineffectively applied. In explanation of the disparity, he cites the experiments of Rhode (Archiv für Klin. Chir., vol. ii, p. 123) to the effect that even slight traumatism such as would follow imperfect fixation prevents endosteal repair.

greater importance, however, is the instinctive accommodation to a weakened and sensitive joint manifested in habitual flexion and adduction of the limb. One may conclude, therefore, that adequate protection is almost as important as is the primary correction of deformity, and that the practical neglect of both essentials in the conventional routine, explains the functional disability, formerly supposed to be an inevitable consequence of the injury.

FIG. 16.—A subcapital fracture in a woman seventy years of age. See Fig. 17.

The requisite for union of a central fracture of the neck must be prolonged fixation of the fragments in normal relation, and since this can be assured only by the abduction method one may disregard the conclusions of the past as to the incapacity of the tissues for repair as purely speculative. In some cases the process of repair proceeds as in other situations. In others there appears to be a preliminary, so-called absorption of part of neck, but in most instances the fragments eventually unite if contact is maintained for a sufficient time. There are doubtless cases in which non-union is inevitable, but even if it were the rule, rather than the exception, one would still apply the abduction method because it has been proved that efficient treatment of the fracture is the most conservative treatment of the patient.

FIG. 17.—An X-ray picture showing bony repair after "absorption" of part of the neck. This patient was presented before the Surgical Society to illustrate a perfect functional result.

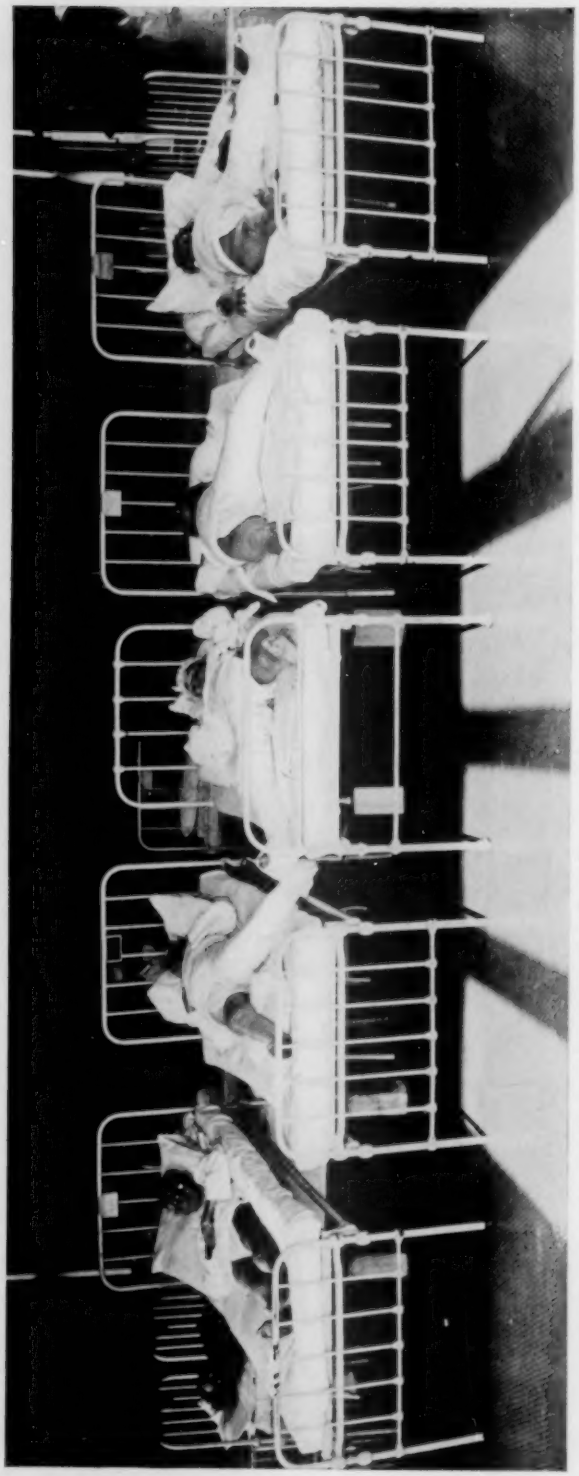


FIG. 18.—Five patients under treatment in one of whom the plaster has been removed for massage and exercise.

Since if properly applied, the abduction method assures fixation of the fragments, the insertion of nails or screws is unnecessary and even harmful,[9] because of injury to the cancellous structure on which repair depends, and if, as in some instances, there were subsequent absorption of the central part of the neck, the fragments would actually be held apart rather than apposed.

With this procedure may be classed primary bone pegging and artificial impaction, because all are based on the fallacious assumptions that accurate apposition of the fragments may not be maintained otherwise, and that by such means

[9] Delbet and Basset (Fractures du col de fémur, 1921) state that they have never seen union of an intracapsular fracture except in cases fixed by a metal screw. They report 35 cases treated by this method in which there were 5 deaths and but 4 cases of bony union (13 per cent.). Löfberg (Acta Chir. Scan, July 12, 1924) reports 70 cases of transcervical fracture, treated by the Whitman method with bony union in 39 (55 per cent.) and good function in 90 per cent.

security may be assured during the process of repair without efficient external support.

Admitting that an autogeneous bone peg may in some instances promote union which might not otherwise occur, the functional results are often far from satisfactory, and in any event the cases in which such an operation would be advisable or practicable are relatively insignificant in number.

It may be noted in this connection that the advocates of these methods, at best of doubtful expediency, even as adjuncts of the abduction treatment, usually draw a sharp distinction between extra- and intra-capsular fractures, dismissing the former group as of slight importance because, as one writer expresses it, such fractures "get well anyhow under any treatment good or bad." One has only to apply this statement to other fractures with similar potentiality for repair to emphasize the complete disregard of function that has always characterized the treatment of this particular fracture.

The abduction treatment, because it is comprehensive in its scope and equally effective for every type of fracture, has raised the most neglected of all fractures to the first place in the therapeutic scale, for it is evident that in proportion to the greater obstacles to repair that it presents, the more essential to success must be favorable opportunity, since without opportunity failure is inevitable.

Furthermore, if one accepts the statistics of Löfberg and Waldenström, which are the most complete that have ever been presented, as fairly representative, it would appear that the death rate under normal conditions is about 10 per cent. That at least half of the transcervical fractures and all of the extracapsular type unite by bone. Assuming then that the two forms of fracture are fairly equal in number, one may offer a favorable prognosis both as to life and function in 75 per cent. of all cases treated by the abduction method if it is effectively applied.

At the present time the opposition to the general adoption of the abduction treatment is rather of the nature of inertia [10] than of loyalty to the ancient ritual, the chief objection being, apparently, that its application, particularly the adjustment of a secure and comfortable plaster spica, requires more skill and experience than is possessed by the "average worker." This proposition, in effect, that incompetence should disqualify the treatment rather than the surgeon, however logical under the old dispensation, is no longer tenable. For traditional authority having been disproved and discredited can no longer assure immunity for inadequacy, inefficiency and neglect.

[10] "On a cependant toutes raisons de continuer de l'appeler méthode de Whitman, car c'est a Whitman que revient en somme l'honneur d'avoir brisé le negativism concernant les fractures du col fémoral." Waldenström, *loc cit.*

EDITORIAL ARTICLES

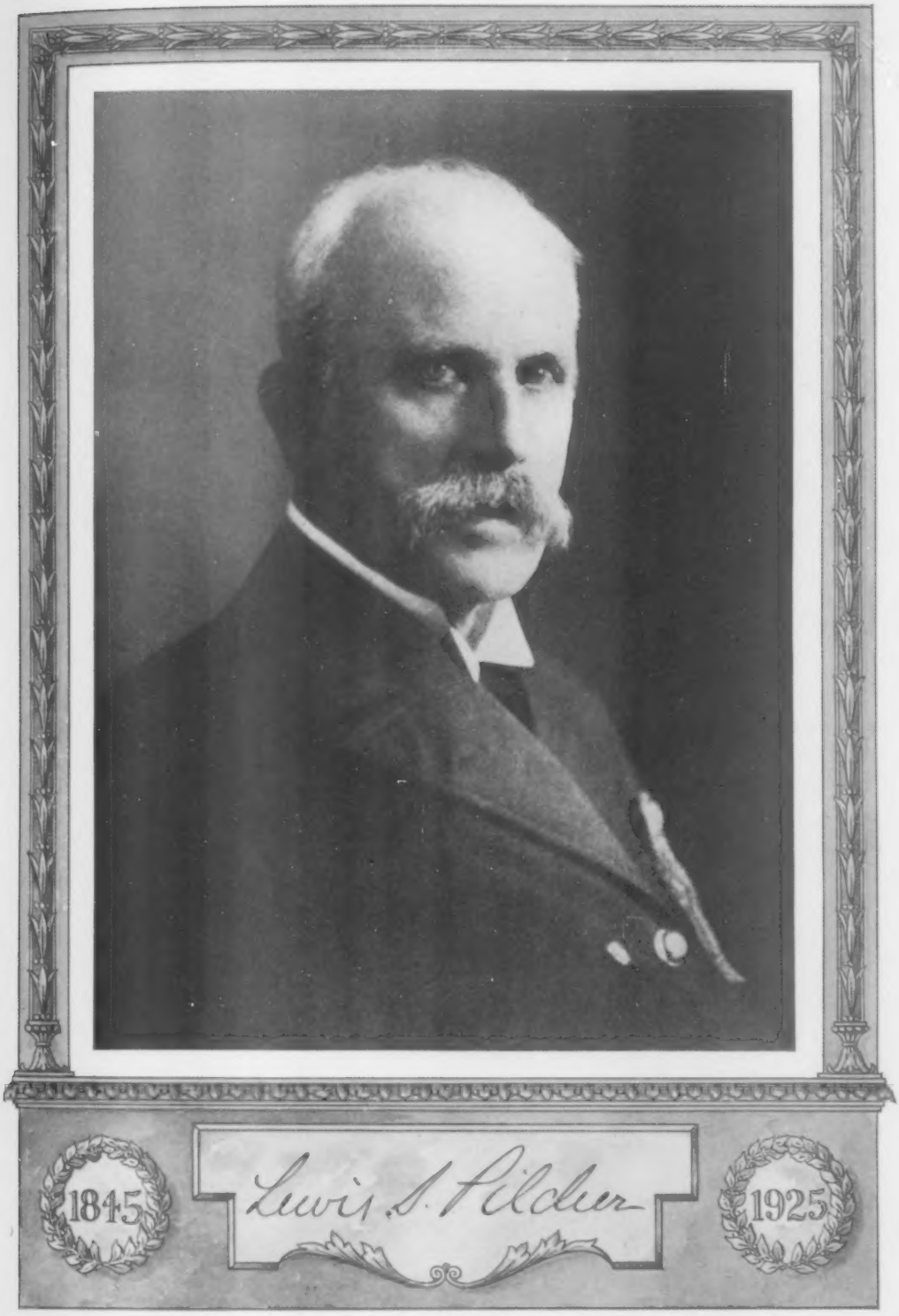
THE STORY OF THE ANNALS

THE winter and spring of 1884 it was my privilege to spend in Germany and England, in study of the work and in observation of the personalities of many of the surgical leaders of that day—Schede in Hamburg with his sublimat technic, Esmarch in Kiel with his Waldwolle and Dauer-verband, von Bergmann in Berlin, recent successor to the illustrious von Langenbeck, and also Hahn at the Friedrichshain Hospital, Hagedorn at Magdeburg, Volkmann at Halle, still using abundant irrigations of carbolic solutions in his operative work, but no longer using the Listerian spray, Thiersch at Leipzig, master of salicylic acid as an antiseptic, Maas at Wurzburg still using the carbolic spray *en rigueur*—the clinic of each in turn had been visited by me. Finally, I was in London with the prospect of a whole month before me for the enthusiastic use of its opportunities. Now for the first time I followed Joseph Lister at the King's College Hospital, whom I had missed in my previous visit in 1878, and was led to compare his rather primitive methods of antisepsis with those that had already begun to be developed in some of the clinics of Germany. The extraordinary genius of Lawson Tait I could not fail to appreciate, while at the same time his prejudices and his pugnacity were unmistakable. The scholarly attainments of Timothy Holmes and of John Marshall and of Sir James Paget made most impressive the generous and fine manner with which they responded to my interviews with them, and gave me an insight into the best development of the surgery of the school of John Hunter and of Sir Astley Cooper.

Excursions to Edinburgh and to Glasgow gave me the acquaintance of Thomas Keith, John Chiene and William Macewen, each pioneers in their own field, in the newly opening opportunities of surgical endeavor.

In London, however, it was natural that I should find especially sympathetic companionship with younger surgeons of my own age among whom were Rickman J. Godlee and Charles B. Keetley, to both of whom I was indebted for many courtesies.

One evening in April—I find on referring to an old memorandum book that it was Friday, April 11, 1884—Keetley was dining with me at the Holborn Viaduct Hotel. The after-dinner talk turned upon the theme of possible future surgical journalism. We lamented that as yet the new surgery, the beginnings of which were unmistakable, had not called into existence in the English tongue, any special journal devoted to its record and contributing to its development. The English and the American surgeon speculated upon the value and the possibilities of an international surgical journal in which the work of our two nations should be united, but to neither of us did the idea seem anything more than a dream. True the American surgeon had for the previous four


1845
Lewis S. Pilcher
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years been engaged both as editor and proprietor, in an effort to develop such a journal, in publishing the *Annals of Anatomy and Surgery*, the outgrowth of the work of the Anatomical and Surgical Society of Brooklyn, New York. That experience had given him, however, a vivid realization of the laborious task and the pecuniary burdens which such an enterprise involved as well as a realization of the administrative aptitude which was requisite to carry it on. He had endeavored to interest the great medical publishers of New York and of Philadelphia in the idea of a journal devoted to surgery, but without success, and when at the close of the year 1883 he had determined to devote a large portion of the coming year to travel abroad, he had wound up the affairs of his journal without any expectation of ever again reëntering the journalistic field, and had sailed away with a distinct sense of relief from a heavy burden that he was to carry no longer.

So to that discussion in the London tavern four months later he was able to contribute an experience that lent no encouragement to the proposed enterprise as far as he was concerned.

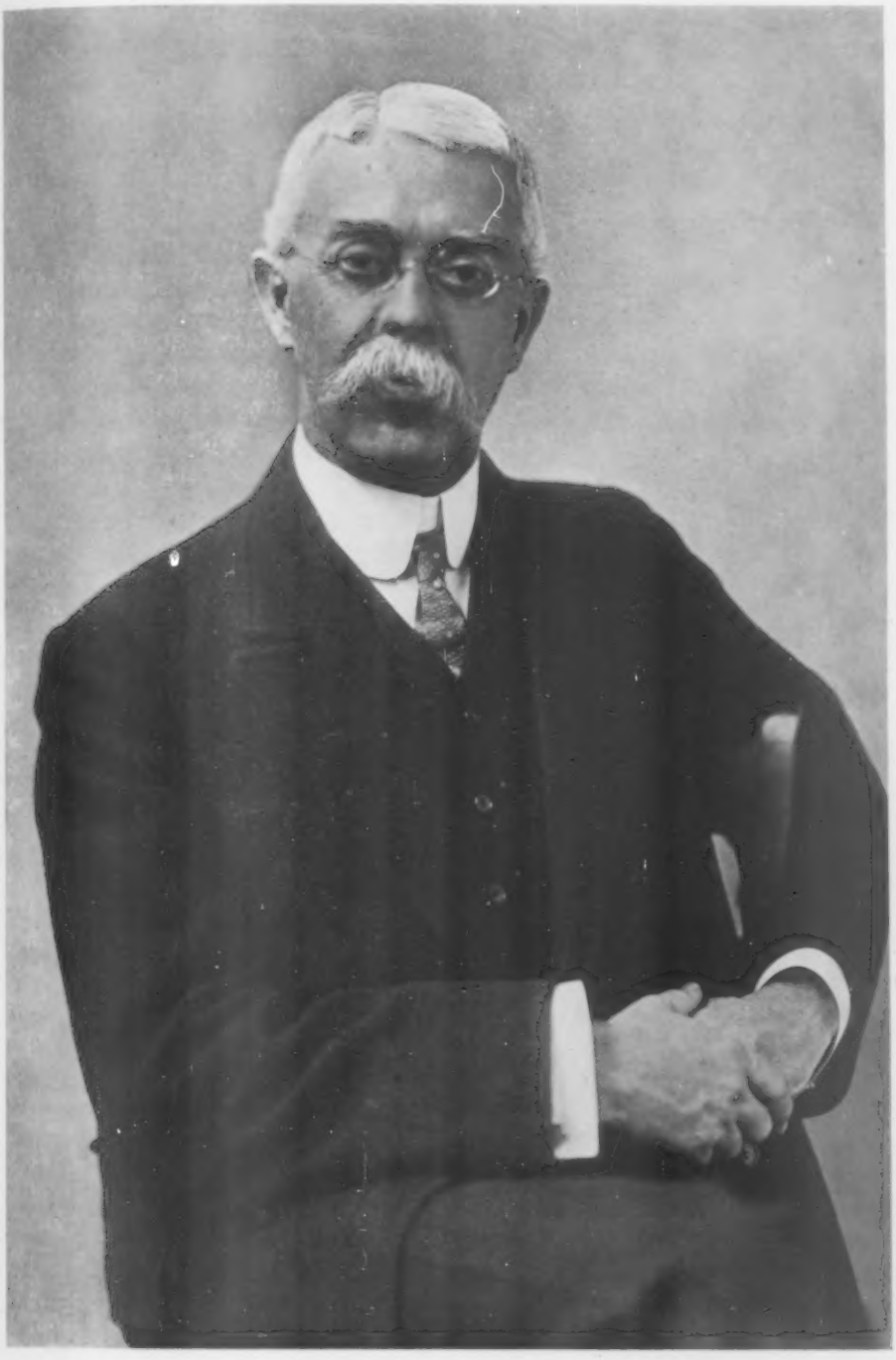
When I arrived at home early in May, I found waiting to see me a gentleman who announced himself as a publisher from St. Louis, who wished to discuss with me the feasibility of undertaking the publication of a journal devoted to Surgery! From a considerable experience as the publisher of medical journals, he expressed himself as confident of the business success of such a journal of high class, a confidence in which he had been strengthened by discussions with Doctors Nicholas Senn and Roswell Park, of Chicago, who, he said, had recommended him to interest me, if possible, in its editorial management. This was James H. Chambers, publisher of the *Weekly Medical Review*, of which journal Doctor Park had been the editor. It needs no imagination to realize what great interest such a proposition had for me. I had dreamed of such an enterprise, but had finally abandoned the thought of it as impracticable, at least for me. Now here was an experienced medical publisher, who practically proposed to fully assume all the responsibilities, labors and expenses of publishing such a periodical, while to me was guaranteed absolute control of the scientific contents of the journal and censorship of the advertising pages. Unexpectedly a door was opened which exposed an attractive vista to me. After suitable time for reflection and discussion between Mr. Chambers and myself, an agreement was reached and a contract was made under which a monthly journal to be called *The Annals of Surgery* was to be edited and published. The first number bore the date of January, 1885. For forty years since that date the journal has continued to appear without intermission; twice during that time the proprietorship has changed, but the editing of its contents has gone on under the original contract unchanged under the same personal direction with which its first number was prepared. As visualized by its editor, such a periodical could not be a very popular one. At that date the number of surgeons, as distinguished from general practitioners, was not very great, but their number was constantly increasing, and

as hospitals multiplied and the domain of surgical effort was constantly being extended, the number of able workers in the surgical field was correspondingly increasing and the material worthy of being recorded was constantly gaining greater output.

I at once communicated with my London friend, Mr. Keetley, whose interest in such a new departure into surgical journalism our very recent after-dinner talk had made well known to me. He at once assured me of his readiness to coöperate and together we perfected the plans for carrying on the proposed journal. For seven years we collaborated in the development of the new publication. Mr. Keetley's association in this work was real, not nominal. The first number of the ANNALS OF SURGERY bore the date of January, 1885, and as it editors, its title page bore the names of Lewis S. Pilcher and Charles B. Keetley. The first original memoir inaugurating the new journal was from Keetley's pen. The first editorial article, "Annus Chirurgicus, 1884," was the joint production of the two editors, an article in which was given a summary and review of the chief surgical achievements of the preceding year in America, England, and on the Continent. During the earlier years of the life of the ANNALS, contributions from British surgeons formed an important part of its contents. A department was organized entitled "Index of Surgical Progress," in which were given abstracts of the more important surgical memoirs published in all countries in the compilation of which many of the younger British surgeons were enlisted as collaborators. From time to time were published more formal and extended editorial articles reviewing and analyzing work done in special fields. Book Reviews likewise gave opportunity to call attention to much that was new and important in the growth of the rapidly extending domain of surgery. It was our ambition to make the ANNALS OF SURGERY worthy of its claim to be a "Monthly Review of Surgical Science and Practice," especially since up to that time at least, it was the only journal of its kind published in the English language.

Surgery in the '80's was just beginning to show the wonderful impetus that had been given to it by the new knowledge of the agency of microörganisms in wound disturbances. The questions of sepsis and antisepsis were not even yet fully answered, much less completely embodied in surgical faith and practice. In chronicling and disseminating the knowledge of the rapidly accumulating new facts and theories of the period, the ANNALS happily became an early and important factor, while it ever steadily kept before it a high conception of the best ideals of the profession.

It would be interesting and profitable to compare and contrast the surgeons, the hospitals, the surgery of 1884 with that of 1924, nor would it be entirely to the disadvantage of the men who labored under the conditions of forty years ago. I shall not attempt it here. May I not say, however, that then were being laid the foundations upon which the structure of to-day was to be built. But a few years before, one of the most eminent British surgeons in a public address had expressed the opinion—*ex cathedra*—that surgery had



then reached the farthest bounds of its possible development. Then came Pasteur and Lister and opened a door hitherto unsuspected, through which was revealed a new surgical world of boundless possibilities. It was into this new world that the ANNALS OF SURGERY was born and it has been its privilege to be a part of it during the brilliant generation which has followed, so many of whose triumphs it has been its lot to help make known, as each successive issue through these nearly five hundred monthly numbers has gone to its readers through all parts of the earth.

The office of publication continued in St. Louis for seven years. To edit a journal in Brooklyn and London and to publish it in St. Louis had at times its inconveniences, but these were never serious. With the issue of January, 1892, however, the imprint of the University of Pennsylvania Press, of Philadelphia, was substituted for that of the St. Louis publisher following the transfer of ownership to the former. The new owners, in pursuance of their policy to engage in and foster the publication of scientific and literary material of high merit, worthy of the great University whose name they bore, had acquired this journal and proposed to give to it the support that was at their command. Perhaps no more flattering testimonial to the character of the work which the ANNALS OF SURGERY had manifestly been doing up to that time could have been given than such an endorsement from such a source. Lewis Pilcher was continued in the editorship, and associated with his name on the title page of the issue of January, 1892, as Editors appeared the names of J. William White, of Philadelphia, Frederick Treves, of London, and William Macewen, of Glasgow.

The removal of Mr. Keetley's name from the title page of the ANNALS OF SURGERY was a matter of regret to me, but I recognized the propriety of a preference being exercised by those who had become the proprietors of the journal, especially as their choice could not fail to be eminently agreeable to me. Mr. Keetley continued to be a friend to the ANNALS and a personal correspondent of his colleague up to the time of his death which occurred seventeen years later, in December, 1909, simultaneously with the publication of the last number of the fiftieth volume of the ANNALS, the last original memoir in which number was from his pen. Charles B. Keetley was a skilful, progressive and bold surgeon, a man of wide interests, generous, self-sacrificing and tenacious, restless, earnest and open-minded. I had found in him a sympathetic, laborious and helpful colleague; I lamented him as a true and constant friend. He died at the comparatively early age of sixty-two years.

Dr. J. William White's services to the ANNALS OF SURGERY were of importance. It was through his initiative that the University of Pennsylvania Press acquired the journal and transferred its place of publication to Philadelphia. It was through his influence that first *Frederick Treves* and later *Watson Cheyne* were induced to give the weight of their names to the journal as collaborating editors. Doctor White was ever on the watch to foster the

Frederick Treves

welfare of the journal, an interest which he continued up to the time of his death in 1916 at the age of sixty-six years.

Although upon the title page of the journal there was for some years no distinction made as to the relative editorial responsibility of the members of the editorial staff, practically the entire management of its columns remained vested as before, and the ideals of the guidance, the shaping of its policies, the choice and preparation of its contents continued unchanged. During the many years—twenty-five in fact—during which Doctor White's name continued to appear on its title page the utmost courtesy and consideration were ever shown by him to his colleague; no jar in our mutual relations ever occurred; whenever he was called upon for advice or contribution of any kind he was quick to respond.

The relations of Mr. Treves to the journal continued for a number of years. The rapidly increasing demands upon the labors of that eminent surgeon soon, however, became such as to cause him to ask to be relieved of even the nominal relation to the journal which he had accepted and at his request, *Mr. W. H. A. Jacobson,* of Guy's Hospital, was substituted in his place in January, 1896.

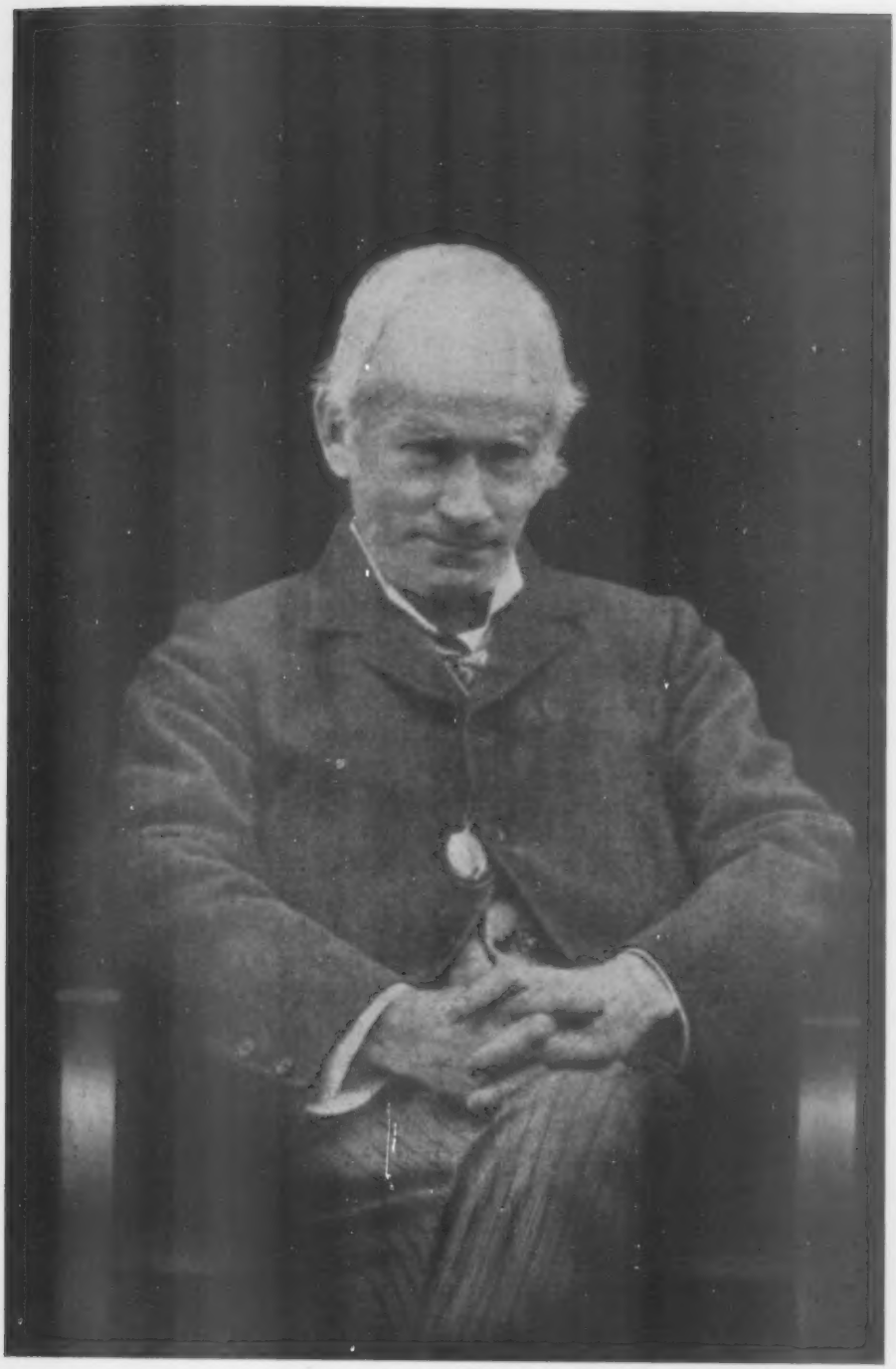
Sir Frederick Treves died in Switzerland in December, 1923. As surgeon in succession to King Edward and King George he had attained to the most conspicuous position among the surgeons of Great Britain, but his high fame was due quite as much to his own forceful and winning personality, and to his eminence in the art and science of surgery and to his ability by voice and pen to command the attention of men as it was to royal favor. He was seventy-three years of age at the time of his death.

Mr. Jacobson ever displayed a deep interest in the journal to which he lent his name. But ill health compelled his relinquishment of all professional work in 1903, and with other things he asked to be relieved of the position he had assumed with the ANNALS. He lived in retirement for many years thereafter and quite recently, September 14, 1924, his death is announced at the age of seventy-seven years. Mr. Jacobson was a scholar as well as a surgeon. He was a genial, warm-hearted man; of sharp wit and somewhat eccentric manner, due to a naturally supersensitive nervous organization. He was best known by his work on "The Operations of Surgery."

Of the trio of eminent surgeons who gave their endorsement to the new surgical journal when it was transferred to Philadelphia in 1892, White, Treves and Macewen, the counsel of none was more valued, the friendship of none was more firm and lasting, and the interest of none was more positive than that of the illustrious Scotch Surgeon, *William Macewen.* His connection with the ANNALS ceased only with his death, which occurred in March, 1924, at the age of seventy-six.

As indicative of his special interest, I cannot refrain from inserting in *fac simile* the following characteristic letter of his which I believe will have a special interest to the readers of the ANNALS OF SURGERY.

Many letters of encouragement and of suggestion were received from him



WALTER HAMILTON ACLAND JACOBSON

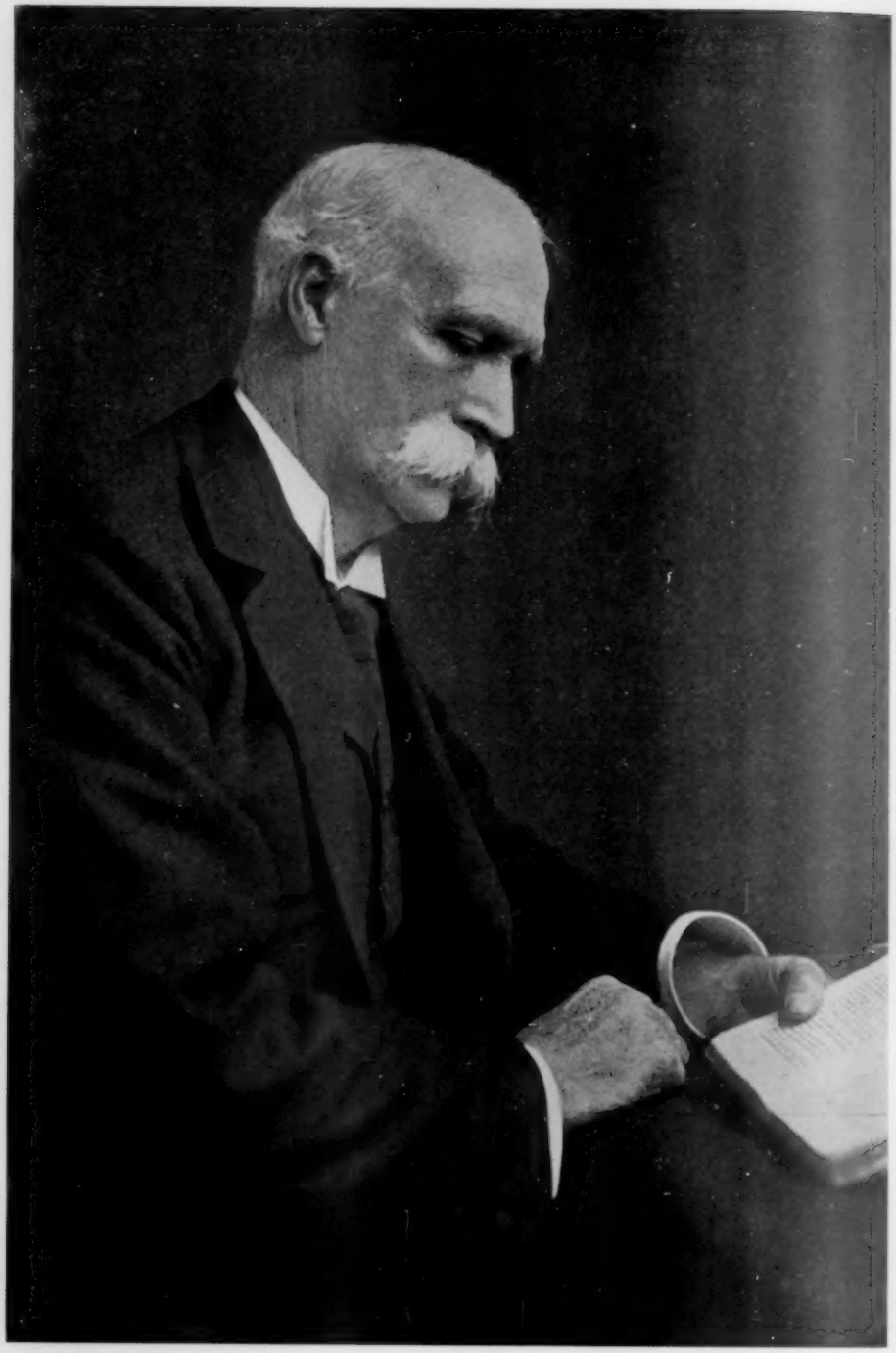
by me during the long period of over thirty years of his association with the editorial staff of this journal. Sir William Macewen was a surgical philosopher, equally interested in the scientific as well as the practical aspects of surgery. His life was devoted to research. He ever preserved that open mind to which all things that promised good were equally welcome. He was of commanding presence, with a clear and resonant voice that added to his power as a teacher. He was a brilliant and original operator. For forty-seven years he kept up his work, as an active hospital surgeon. His death, March 22, 1924, occurred shortly after his return from a trip to Australia. His name will always be connected with cerebral surgery and bone regeneration. For the excellent portrait here reproduced of this great surgeon we are indebted to a print furnished by his daughter, Miss Margaret Macewen.

When Mr. Jacobson retired from active work, the ANNALS OF SURGERY was fortunate enough to secure the acceptance by *Mr. W. Watson Cheyne*, of King's College Hospital, of the vacant place, a relation that continued for twenty years, until he, too, now Sir Watson Cheyne, retired from active work as a surgeon as the result of the multiplying years. As a pupil and coadjutor of Mr. Lister, Mr. Cheyne had enjoyed the privilege of being one of the early and most influential exponents of the new doctrines of antisepsis. He ever ably assisted his honored chief in all his work and when the latter, under the burdens of advancing age retired from the wards of King's College Hospital, Mr. Cheyne succeeded to the place left vacant. His important work in South Africa during the Boer War was acknowledged by his elevation to knighthood by his Sovereign. All the well-earned honors of a life devoted to the highest ideals are still his to enjoy in the country home to which he has retired.

At Sir Watson's nomination the place on the title page of the ANNALS vacated by him was filled by *Mr. W. A. Clayton Greene*, of Westminster Hospital, in 1922. This relation was, however, quite brief owing to the illness of Mr. Greene, which compelled him to give up his surgical work early in 1924. The London collaboratorship thus laid down, was then accepted by the well-known surgeon of Middlesex Hospital, *Mr. W. Sampson Handley*, whose work, especially in the field of cancer, has made his name familiar to all surgeons. Mr. Handley's interest in the ANNALS has already been manifested in many ways, particularly by the study of lupus contributed by him to the present Commemorative number. It is to be hoped that the years of his association with the ANNALS OF SURGERY may equal, possibly exceed those of his distinguished predecessors, Macewen, Cheyne, and White!

While no very great share in the details of the work of the journal is to be expected from these collaborators, it still remains that the willingness of men of such recognized eminence in the profession of surgery to permit their names to be associated with it, is an evidence of their interest in its aims, their satisfaction with the manner in which it is being conducted, and a guarantee to the craft of surgeons everywhere as to the quality and character of the publication.

W. Watson Cheyne



3 Woodside Crescent,
Charing Cross,
Glasgow.

My dear Dr. Pilcher,

Doubtless you are aware that a new British Surgical Journal is being launched and a note for subscribers is being sent round. I was asked from several sources to join the undertaking and replied that while wishing them all success, that I could not entertain their proposal as I had been so long associated with the Annals of Surgery that I would not care to join a new journal. I thought also that the Annals had played its part so well and for so many years that it deserved all the support we could give it on this side. I thought you should know why my name does not appear among the promoters of the new Journal.

I have forwarded you a short paper by a Dr. Hull which might find a place in the Annals.

Yours faithfully,
(Signed) WILLIAM MACEWEN.

May 3 1913.

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"My dear Dr. Pilcher:—

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May 3, 1913.

Yours faithfully,
(Signed) WILLIAM MACEWEN."

I have always counted it a great honor that such men have been willing to support me for such long periods in efforts to create and maintain a surgical journal of the highest standard.

In the spring of 1897, the ANNALS OF SURGERY was acquired by the great publishing house of Philadelphia, the J. B. Lippincott Company, and the first number of the twenty-sixth volume, July, 1897, bore the imprint of that firm. The journal was no longer an experiment of uncertain viability. It had obtained a place among the recognized journals of the first class in the literature of Medicine and behind it henceforth was now to be a hundred years of publishing experience and the capital of one of the great publishing firms of the land. More fully and certainly than ever were to be realized the hopes and ideals which had inspired its beginnings. The aims and standards that had always controlled the policy of the journal were fully shared by the ultimate publishers into whose control it had now fallen, and an *entente cordiale* was at once established between imposing rooms, counting house and editorial desk that has grown stronger and more satisfactory, if possible, with the lapse of years. I would like to believe that the words of praise for this child of my creation which are often spoken to me were to be accepted at their face value. Certainly the labors of so many years have brought to me many expressions of esteem and appreciation which are most highly valued. What greater evidence of the position which the ANNALS OF SURGERY has conquered for itself in the surgical world could there be than the number and quality of the surgical memoirs that have been offered by surgeons from many lands to be embodied in this Commemorative number which marks the completion by its Editor of forty years of work for it? As I look upon the long series of its bulky volumes that fill the shelves of my library, I am amazed at the work that has been accomplished. The original monthly output of 96 pages has been increased to 160 pages, each of those of the present day, moreover, containing nearly three times as much matter as did those of the first issue. And all this but a partial record of the surgical progress of the years that have passed. Day by day the work has gone on interspersed with a multitude of other duties and labors that each day has brought to light. Nearly every line of all these volumes has passed under my own eye; has been collected, often extensively edited and always prepared for the compositor, final proofs read and the completed making up into monthly numbers decided upon by myself, for such is the duty of an editor. But the work has been an enjoyable one. It has been rendered possible, even easy, by system and habit and aptitude. As an active surgeon, it has kept me to an unusual degree *au courant* with the work of my fellows; it has brought me into personal acquaintance with the active workers of my profession far and wide, and when each completed monthly issue finally comes to my table, it brings with it a sense of satisfaction with good work accomplished that is ample reward for much of tedious labor in the previous preparation.

The establishment of such a publication as the ANNALS OF SURGERY was

W. Sampson Handley

the natural outcome of the new conditions in surgery that had begun to engage the attention of surgeons in the seventies and eighties of the nineteenth century. The whole field of surgery was undergoing revision; new avenues were constantly being opened; what was to be the end did not yet appear, but it was important that special media for the presentation and diffusion of knowledge as to the progress of events should be created. It was at that period that special associations of surgeons began to be formed in the United States. Fathered by Samuel D. Gross, the American Surgical Association was formed in 1880, and at about the same time, under the leadership of Henry B. Sands, the New York Surgical Society came into existence.

The Philadelphia Academy of Surgeons began its work also in the eighties. The regular publication in the ANNALS OF SURGERY of the proceedings of those two societies was inaugurated in 1893 and has continued without intermission to the present time, constituting a Department of Clinical Reports which most faithfully represents the advances in practical surgical work which the successive years were witnessing. These records of the work of these two societies I have always regarded as of an importance not exceeded by anything else which the journal has contained. Many of the memoirs presented at the annual meetings of the American Surgical Association early began to appear in the pages of the ANNALS. In increasing numbers such papers have continued to appear as the years have progressed until now a large proportion of all the papers read before this society find a wide and early dissemination through its pages, a fact which has always given its editor an intense satisfaction. When the first number of the ANNALS OF SURGERY was put in the mails in the last week of December, 1884, there was no other purely surgical journal printed in the English tongue. German surgery had for years been represented by able and important periodicals. France had only a short time before made a beginning in its *Revue de Chirurgie* to worthily chronicle the work of its surgeons. During the years that have passed since, there have later come to the table of the ANNALS OF SURGERY a succession of surgical journals in many languages which reflect ably the progress in the minds of men and in the recognized activities of the world which surgical science and practice has made and is making. Among these later journals those of American origin maintain places of preëminence, whose advent the ANNALS has welcomed as of worthy colaborers, awakening mutual emulation, colaborers whose presence and success is an evidence of the growth of the surgical enthusiasm of to-day, and a promise of a rich fruitage in the future.

The multiplication of hospitals and the improvement in the quality of their work, and especially the preponderance of surgical work in all hospitals, has been a very marked characteristic of this period. The formation of many purely surgical societies has been a third most interesting and instructive development. Every large city has its surgical society; every surgical specialty has its special society; special sections of the country's area have been made the occasion for the formation of sectional surgical societies. To regulate

and to inspire the highest possible tone in all this welter of eager progress and change, a great College of American Surgeons has been organized which even aspires in its plans to stretch out beyond the confines of the United States and become Pan-American in its scope.

Surely, surgery has come into its own in these first years of the twentieth century.

In the midst of all this luxuriance of growth and kaleidoscopic quality of change, the ANNALS OF SURGERY has been kept on a steady course as "A Monthly Review of Surgical Science and Practice." A single hand has guided it from the first to the present time by which a continuity and symmetry of policy and standards has been ensured. It is not to be expected that the day of change can be very long postponed. One of the melancholy duties which has attended the preparation of the paragraphs descriptive of the eminent surgeons who in the past have honored the ANNALS OF SURGERY by accepting positions as Collaborators for it, has been to note the death of so many of them—Keetley, White, Treves, Macewen, Jacobson, each has finished his work and gone to his final reward; each one, I cannot help but note, was junior in point of age to the colaborer who has strangely been preserved to do honor to their memory.

The first quarter of the Twentieth Century has already gone into history. The sons and grandsons of those who were the surgical leaders of the "Eighties" now occupy the field! With what enthusiasm, what skill, what research, what devotion, what triumphs is the record of their work filled! What promise for the future does it not give!

It has been a wonderful privilege to have lived from 1845 to 1925. It will be a great joy to pass on the torch kindled during these years in the fires of the Surgical Altar to the eager and capable hands which are even now stretched out to grasp it.

LEWIS STEPHEN PILCHER.

FELLOW WORKERS' APPRECIATION OF TWO SCORES OF YEARS OF EDITORIAL WORK

WITHIN the forty years just past, many surgical journals have been auspiciously launched in an environment similar to that in which the ANNALS OF SURGERY has developed and succeeded, under the able guidance of Dr. Lewis Stephen Pilcher. A careful study of the life and character of this Premier Editor of a great publication aids one in appreciating his ability to enlist the admiration of all true surgeons of his time. Although he became the Editor of the ANNALS OF SURGERY as many as forty years ago, he was even then a seasoned man in his profession who had touched in a practical manner the great character-building phases of his fellow-practitioners and of our country's life; he was not unaware of the resourcefulness of the West; he had experienced the growing pains of the family doctor who practiced among the common people; he had been tested in the overwhelming strife of our Civil War; he had been subjected to the discipline of the Navy, and he knew the fascination of the sea; he had been a part of the great adventure that eliminated yellow fever from the tropics and redeemed them to civilization. These epochs in his life, with the interstices made up of the usual and ordinary experiences that are the lot of every industrious man, developed the stuff that bred a strong, wise editor whose constant guides have been a rare intelligence and extraordinary good sense.

DR. LEWIS STEPHEN PILCHER succeeded in a great editorship at a time when most doctors were too busy with their personal practices and the development of a pioneer organization of a faltering profession to become enthusiastic over ideals in medical literature. The great sense of proportion which abounds in his character gives him the unerring

judgment which he has invariably exercised in the selection of articles for his Journal, and which has made it the "Atlantic Monthly" of surgical literature. He never attempts the spectacular; he selects his material conservatively, and under a balanced and sane policy; he has established his Journal as a leader in revealing the new; he recognizes the workable discoveries that are being brought forth; he fosters the development of the next generation rather than dependence upon the passing generation. The list of men in Medicine whom he has discovered during the last forty years reveals the names of our greatest surgeons of today. And no doubt he is now publishing articles by obscure men who will one day be our surgical peers of the future. While the ANNALS OF SURGERY reproduces only the work of sound and progressive men, its Editor is devoid of snobbishness. By his discrimination, he has taught his editorial confrères to do their work wisely and to maintain at all times the highest ideals. No task within the jurisdiction of an Editor is more important or more difficult of execution than the acceptance or rejection of contributions which are offered for publication. An Editor must possess a judicial mind; he must make his selections wisely and disinterestedly; he must have the courage of his convictions and accept or reject without regard either to the importance or to the obscurity of the author. With all of these requisites the Editor of the ANNALS OF SURGERY is generously endowed.

Dr. Lewis Stephen Pilcher has been a great pilot to the surgeons of this and other continents for forty years. He has set for his editorial confrères a high standard in surgical journalism. May he continue to teach us and to inspire us for many years to come!

FRANKLIN H. MARTIN,

Editor Surgery, Gynæcology and Obstetrics.

TWO SCORES OF YEARS OF EDITORIAL WORK

Even to one who can look back upon a score of years as editor of a surgical journal, two score years of such work seems a long time. It is indeed, an achievement to have guided through four full decades the destiny of the ANNALS OF SURGERY—one of the world's greatest surgical publications and for many years the chief repository of the most important surgical articles in English. Even since it has been sharing this enlarging sphere with other periodicals in America and in England it has continued unsurpassed by any in the quality of its contributions. Perhaps only an editor can fully appreciate the responsibilities involved in selecting such contributions and in establishing standards of literary form and expression in medical writings.

I am happy in this opportunity to pay my tribute to the ANNALS and to LEWIS STEPHEN PILCHER—distinguished surgeon, cultured scholar and Nestor of medical journalism. And I am proud to be among those privileged to make a scientific contribution to this " festschrift " commemorative of his forty years of literary service to a profession he has conspicuously adorned.

WALTER M. BRICKNER,
Editor of the American Journal of Surgery.

To Contributors and Subscribers :

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 145 Gates Ave., Brooklyn, N. Y.

Remittances for Subscriptions and Advertising and all business communications should be addressed to the

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